

# Increasing Access to Post Harvest Technologies to Women Farmers

February 2017



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# 1 | Background

## Increasing farmer access to technologies in Kenya Mango Value Chain using Service Design methods

### Overall aim of the project:

Reducing food losses by > 50 % to improve rural lives

- The service design approach and methods and customer journey mapping will provide a clear objective of needs of female farmers
- The method visualises present actors, stakeholders, thresholds and success factors to facilitate better technology uptake in future

### Mango production and technology in Kenya

- Agriculture is the most important provider of livelihoods in Kenya, with more than 75% of the population depending on this sector for food and income
- Mango is an important food and cash crop and production has increased by > 400 % from 2001-2012 (see Figure 1)
- Currently a significant proportion of the crop is lost (>25%) during and after the harvesting process
- Technology uptake is generally low, and particularly in female led households
- Improved access to technologies are needed → requires understanding of female farmer constraints to technology access
- This study will explore how different technologies can be applied to reduce losses in the Kenya mango value chain

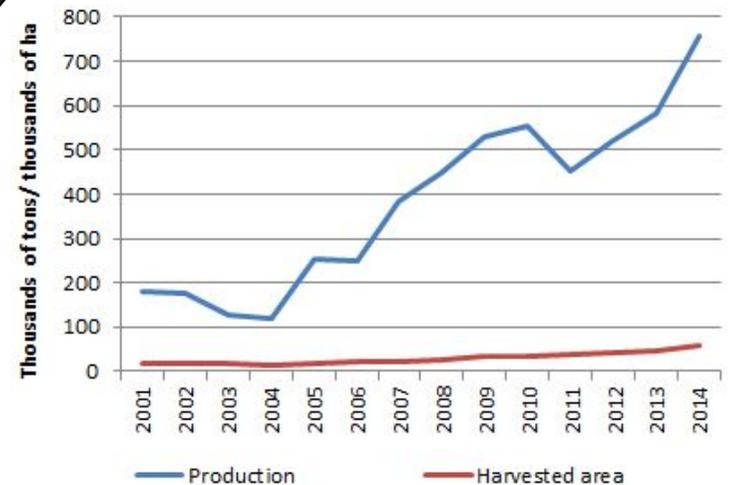


Figure 1. Production of mangoes in Kenya. (FAOSTAT, 2017)

## 2 | Study methodology

### **About service design**

Service Design is a qualitative approach to understanding the particular needs and contexts of the users of a service, product or system. There is no fixed definition of service design as a discipline; rather there are a number of defining principles of service design as an approach.

**User centered** – the user of the service or product is placed at the centre of the service design process. Although statistical descriptions of customers are useful, an understanding of habits, socio-cultural context and the underlying motivations of individuals is essential.

**Qualitative** – Gaining authentic customer insights involves the use of tools and methods that allow the researcher to stand in the shoes of the users: to understand their experience of a service in their wider context (Stickdorn and Schneider 2012).

**Iterative** – Research typically begins “wide” to include the whole context and then, for each iteration, the focus gradually narrows. The iterative approach allows for an explorative mindset where “mistakes” will be detected, corrected and learnings fed into the subsequent iteration.

**Co-creative** – Service designers are skilled at listening to the experiences and ideas of different stakeholders and generating an environment that allows for these ideas and experiences to be articulated, evaluated and gradually translated into tangible solutions for framing and/or solving a particular problem. Thus, the design competence is a facilitating role rather than an expert role. Service design has been in use in the “developed world” context for the past 10 years to address challenges and create social innovations across a diverse range of topic areas including commercially focused projects and community development and public sector initiatives, but is yet to be implemented in the “developing world”.

## 2 | Study methodology

### **About Customer Journey Maps and ecosystem mapping**

The Customer Journey Map is an oriented graph that describes the journey of a user through a service, process or system by representing the different actions and stages that affect the decision making process. The Customer Journey Map visualises and gives an objective view of the user's needs, aspirations, and identifies the social, economic and contextual factors that influence their behaviour. There is no single right way to create a Customer Journey Map, so they are often tailored according to each project's properties and goals. Some common components of a Customer Journey Map are:

**Actions** - What is the customer doing at each stage? What actions are they taking to move themselves on to the next stage?

**Driving forces** - What is driving and motivating the user to keep going to the next stage?

**Thresholds** - What structural, process, cost, implementation, or other barriers stand in the way of fulfilling the driving forces and moving on to the next stage?

Ecosystem mapping is a way to add a layer to show other important stakeholders in the system and their relation to the user. By doing this you can create a more nuanced picture of the user and the Customer Journey Map i.e. not only map out the user's primary process, but how this process fits into the bigger picture.

The purpose of creating Customer Journey Maps and ecosystem mapping is create a (visual) common understanding of the user's perspective in order to make well founded decisions on what to take into consideration in order to make a sustainable change. It is important to remember that the Customer Journey Map has no value in itself but should be seen as a platform for coming up with possible solutions. These solutions should then, in a small scale and in an iteratively way (involving the users and other key stakeholders), be tried out, co-designed and refined before scaling up. In this process the understanding of the user and the ecosystem will deepen further.

## 2 | Study methodology

This study has been divided into two modules. The research of the first module was conducted in Tana River County (Coastal region) and the second module was conducted in both Tana River County and Meru County (Eastern Central region). The first module was designed to give an in-depth understanding of the system and stakeholders connected to the harvest and post-harvest handling of mangoes from the women farmers' perspective, including key cultural, social and behavioural drivers of change. This information was crucial in order to know what needs to be in place for a new system to take hold. The result of the first module was a Customer Journey Map and a mapping of the ecosystem.

In the second module, shortlisted existing and potential new technologies were evaluated from an end-user perspective and fitted into the ecosystem map. Technologies were used as “trigger material” in order to generate deeper insights about how best to implement them. In this module we got feedback on how to complement and further refine the technical improvements from women farmers and other key stakeholders in order to fully meet their needs.

Module 1 in numbers:

- 5 days of field research
- 7 different locations in the Tana River County
- Total of 49 field participant interactions (observations, interviews and field workshop)
- Farmers, harvesters, buyers represented
- 1 day of stakeholder workshop with 26 representatives (Farmers, buyers and local politicians)

Module 2 in numbers:

- 7 days of field research
- 13 different locations in the Meru County and Tana River County
- Total of 157 field participant interactions (observations, interviews and field workshop)
- Farmers, farmer organisations, harvesters, brokers represented
- 1 day key informant round table with TechnoServe
- 1 day of stakeholder workshop with 25 representatives (farmers representatives and local technology providers)

## 2 | Study methodology

For the research in this project we have relied on some key specific methodologies, namely:

**Participatory Observations** - In order to gain an in-depth understanding of the mango farmers, their context and process we observed and took part in many of the harvesting and post harvesting activities.

**Contextual Interviews** - By interviewing farmers during the actual harvesting and post harvesting activities we could pick up on behaviours that would otherwise been hard to pinpoint. By interviewing in context we would also get a deeper understanding of the meaning of the data since we literally knew where it came from.

**Field Workshops** - In order to break cultural and language barriers and facilitate talking about underlying and latent needs, we designed some field workshops. The workshops included visual and tangible material for the “respondents” to build, show and interact with thus helping us to gain a more detailed insight into both their needs and context.

**Key Informant Interviews** - In order to gain valuable first-hand knowledge about the topic we conducted key informant interviews with among others representatives from TechnoServe and JKUAT.

**Analysis session based on CJM** - Continuously throughout field research we compiled our data in a customer journey map. By visualising our research data and identifying common themes in the data we could build on each others experiences and identify gaps and areas of interest to focus on in the following days research. We could therefore adjust our efforts continuously according to our findings throughout the field work.

**Stakeholder Workshop** - At the end of each module we compiled our data in the customer journey map. In a stakeholder workshop including both farmers and other key stakeholders we could with their help both detail and verify our findings and our analysis.

## 2 | Study methodology

The design of the research week in each module followed a similar overall plan.

The first 3-4 days were dedicated to field research visiting the mango fields. The first couple of hours we usually spent doing participatory observations and contextual interviews in order to identify the steps, patterns and actors in the mango harvesting process. We watched and interacted with mango farmers as well as harvesters and brokers. In these interactions we looked for the actions, needs and challenges from all the various perspectives.

After observations and interviews we normally offered lunch and had the field workshops. These helped us and the farmers to visualise and put into words their driving forces and latent needs in the mango farming process as a whole: from pre harvest season to harvest to post harvest activities.

Each evening the teams met up and sorted the data into a customer journey map. With this visualisation of our joint knowledge we could identify gaps and uncertainties in our data and frame the following days research focus accordingly.



*An example of one of our field workshop*

## 2 | Study methodology

After finalising the field workshop we dedicated one day to tidying up the customer journey map and preparing for the following days stakeholder workshop.

We invited representatives of the key stakeholders connected to mango harvest and post harvest, for instance mango brokers, representatives from farming groups, mango farmers, NGO representatives, etc. The primary reason for the stakeholder workshop was to verify and refine the data as well as invite other interested parties to share their needs and aspirations in the various stages of the mango harvesting journey. We also used the workshop to gain further knowledge into key areas and to validate some of our hypothesis and analysis.

After the field research in each module we continued the analysis of the data to further refine the Customer Journey Map and the understanding of the ecosystem around it. By clustering our data we could identify the main patterns on which to base our analysis, hypothesis and recommendations on. Based on the collected data and the analysis verified in the stakeholder workshops we could extrapolate the actions, needs, driving forces and thresholds. These key components are required to understand our observations and relate them to the users needs and requirements in order implement a sustainable and successful change in the system.

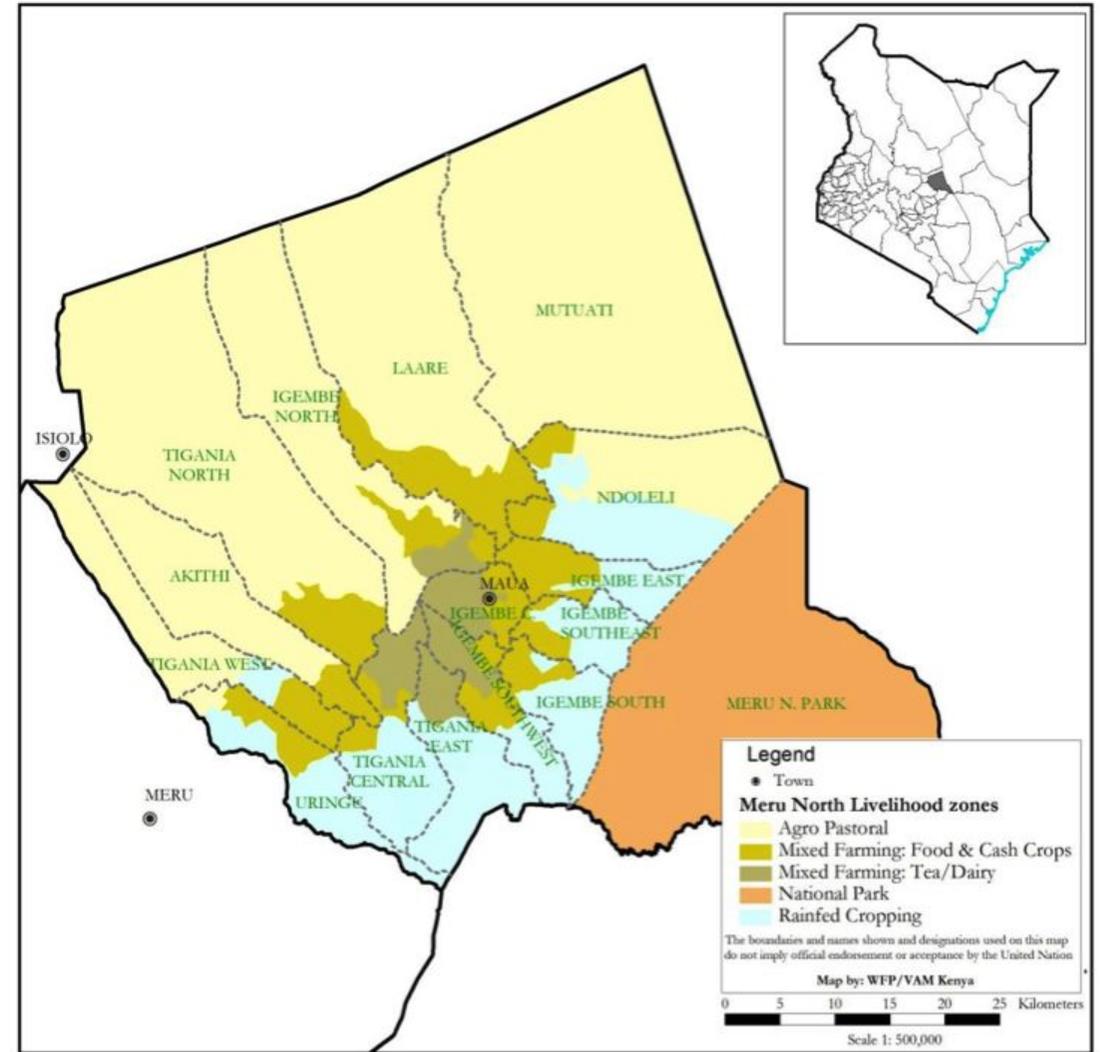
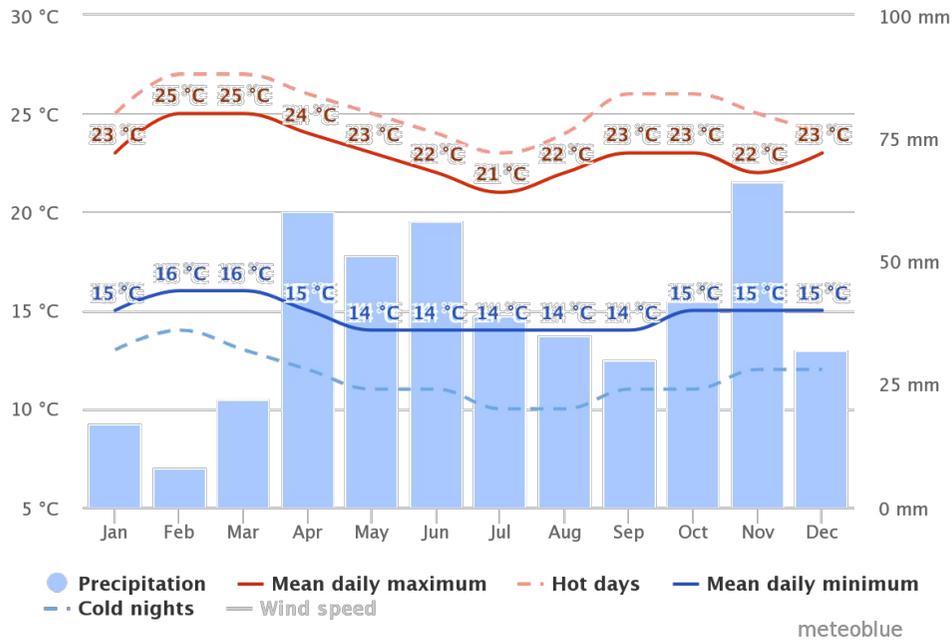


*Break out session, during one of the Stakeholder workshops, where the participants verified and refined our Customer Journey Map*

# 3 | Locations

## Meru

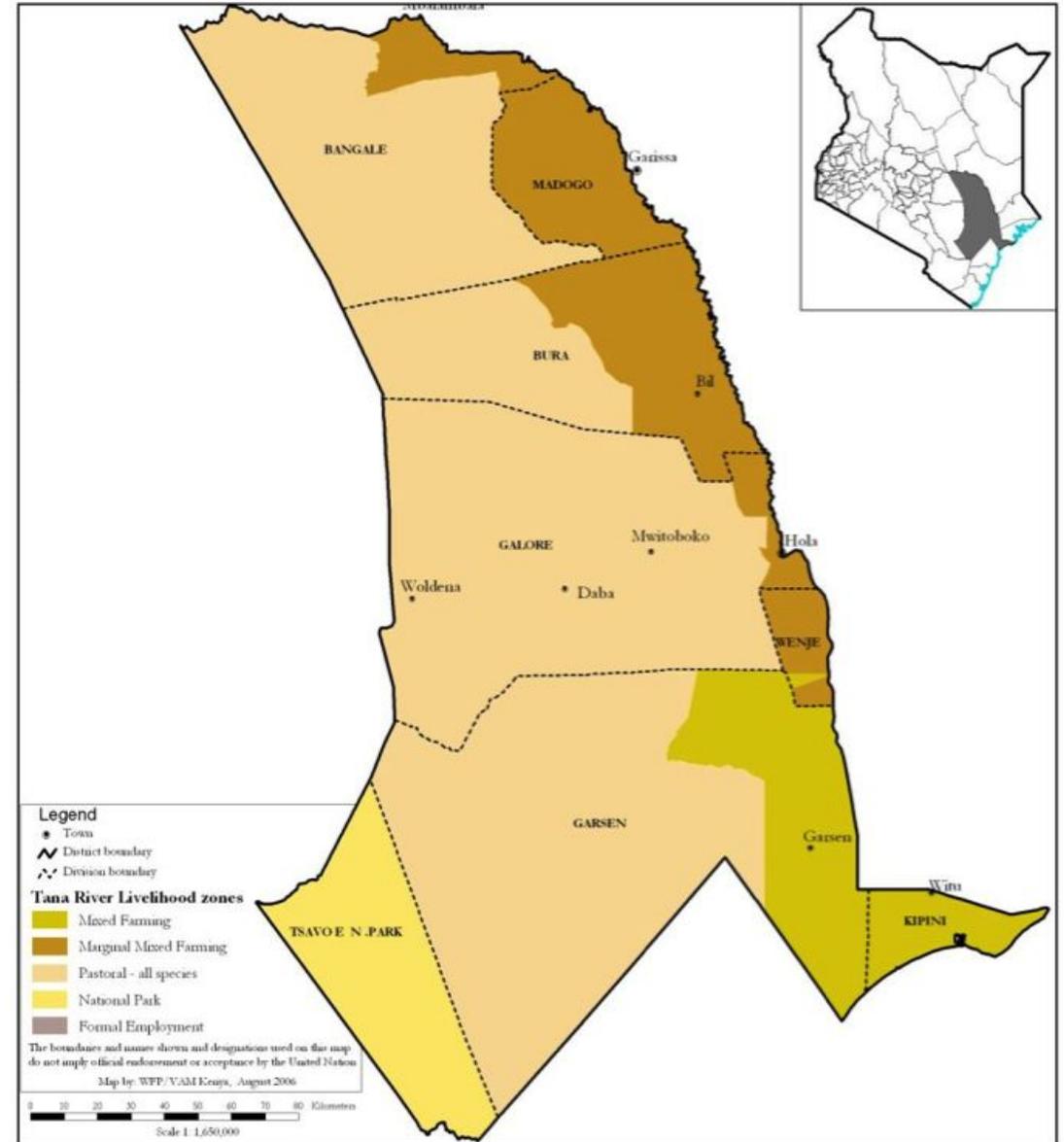
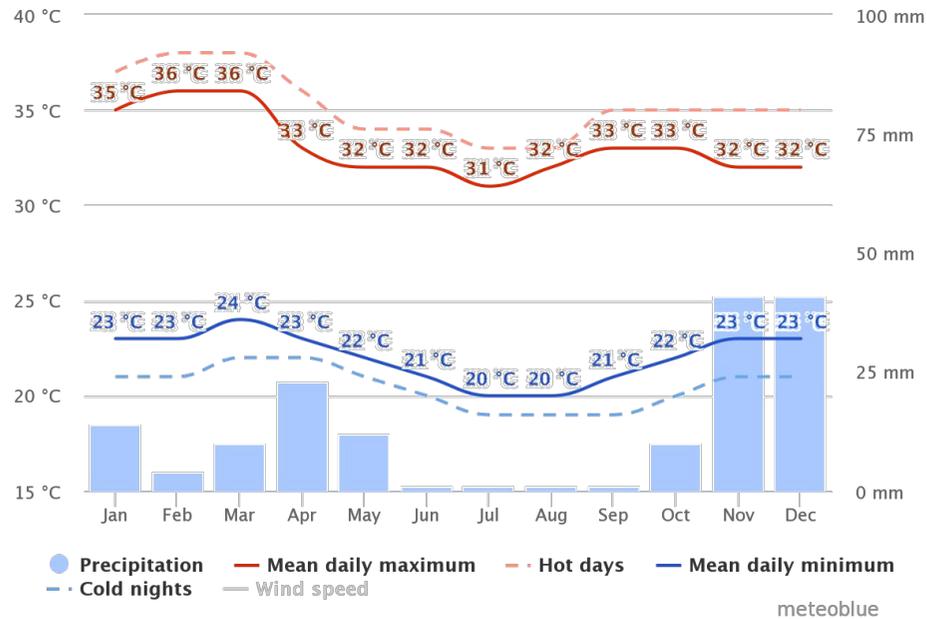
- Eastern Central district
- Majority Christian
- Population: 1,356,301
- Distance to Nairobi, 270 km



# 3 | Locations

## Hola

- Tana River County
- Majority Muslim
- Population 240,075
- Distance to Nairobi 485 km

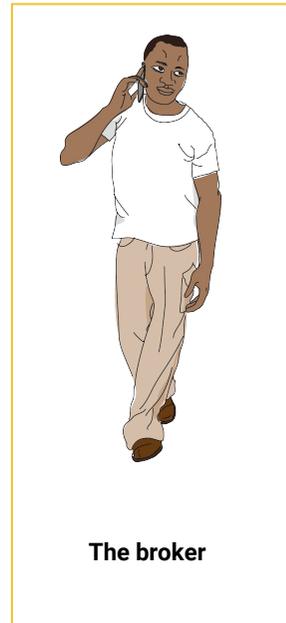


# **4 | The Customer Journey Map**

- **A woman farmer's journey through the mango harvesting process and her relation to other stakeholders**

# The stakeholders in the mango value chain

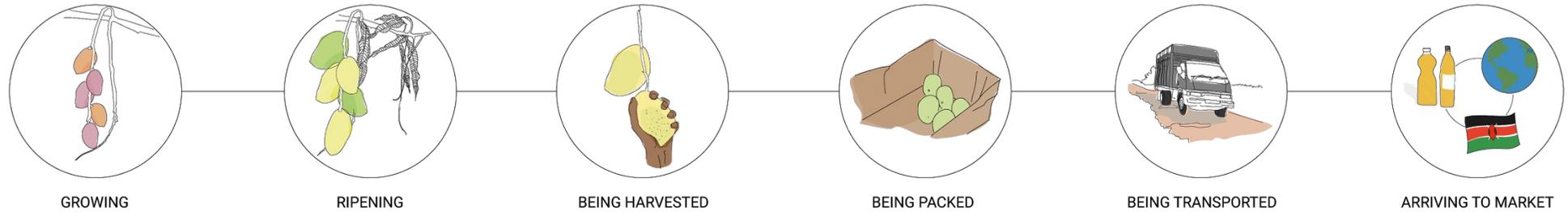
The main stakeholders identified in the mango value chain in Kenya



The fieldwork started off with the aim to look at women farmers experience of harvesting mangoes. However, the research team quickly realised that it is also important to understand the relationship between the farmer and other stakeholders in the value chain as well as the wider market structure. Hence, there were four main stakeholders identified in the mango value chain process, all related to each other in different ways depending on the market structure. The **woman farmer** is in focus. Together with her family she runs the farm, either rented or owned by her husband. They maintain the farm and prepare it for harvest season throughout the year, however they often hire **harvesters** to help out with the actual harvesting. Mangoes provide a source of income for the family, which she either sells directly to the local market or, most often, through a **broker** to the regional or national market, processing industry or export market. Sometimes farmers are organised in **farmer organisations**, enabling the farmer members to handle bigger orders from brokers or end buyers. The farmer organisations are owned by the members, with a chairperson representing them.

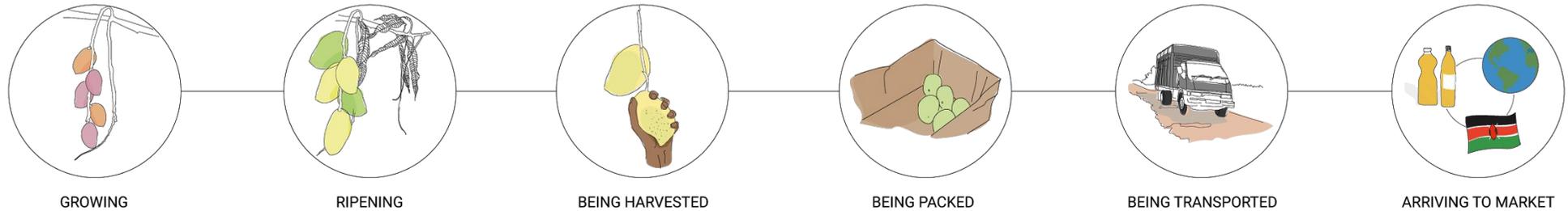
# An overview: The mango value chain in Kenya

We identified a number of different actor scenarios along the mango value chain



# An overview: The main scenarios of the mango value chain

Relations between the main stakeholders and the actor scenarios of the mango value chain

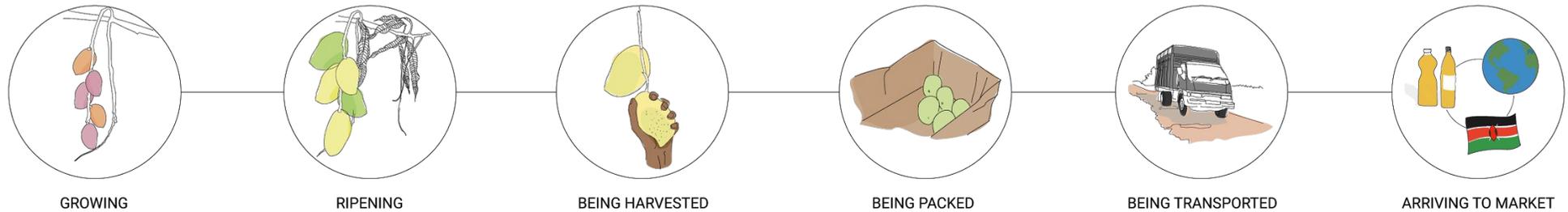


1

In the **first identified actor scenario**, the farmer is involved in the entire mango value chain. The farmer maintains the orchard, ensures there are ripened mangoes and orders to fulfil before beginning to harvest. She harvests the mangoes, packs them and transport them to the market. In the field, we primarily saw this actor scenario targeting local market sales and all the revenue went into the pocket of the farmer and her family.

# An overview: The main scenarios of the mango value chain

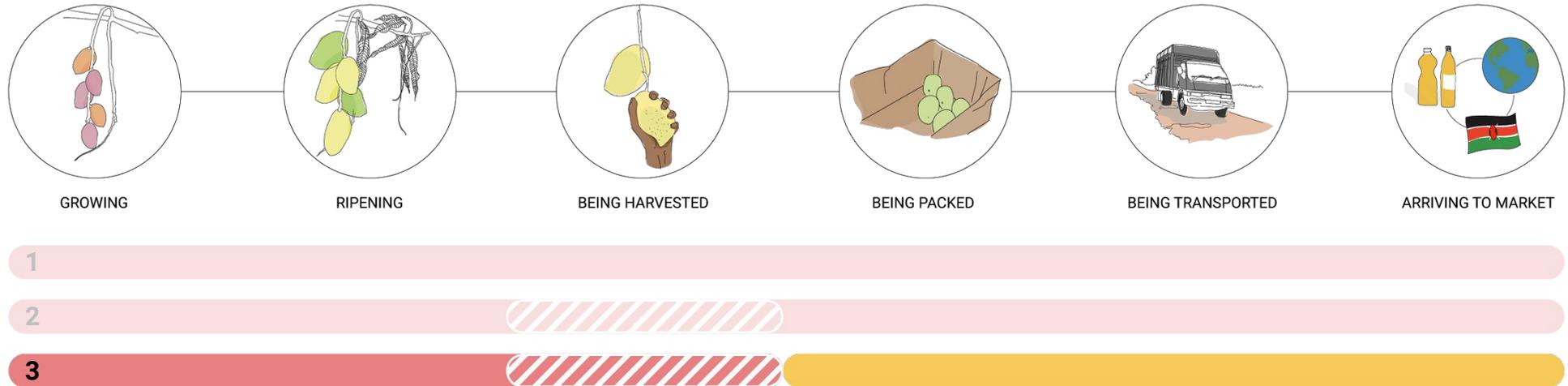
Relations between the main stakeholders and the main scenarios of the mango value chain



The **second actor scenario** is similar to the first one, the only disparity is the fact that the farmer hires harvesters to do the harvesting for them. This reduces the revenue due to payments for external labour costs.

# An overview: The main scenarios of the mango value chain

Relations between the main stakeholders and the main scenarios of the mango value chain



The **third actor scenario** is based on the power relationship and dynamics between the farmer and a broker (or multiple brokers). The first part of the mango journey is controlled and handled by the farmer, enabling her to ensure a good crop. She deals with the broker in an early stage to settle an order and then hires harvesters to do the harvesting for her. After harvesting the broker takes over the control of the order, by grading and packing the mangoes in his/her preferred way and transporting them to the end buyer or market. This scenario results in generally lower revenues for the farmer, as the much of the income is affected by the brokers grading and/or rejection of mangoes.

# An overview: The main scenarios of the mango value chain

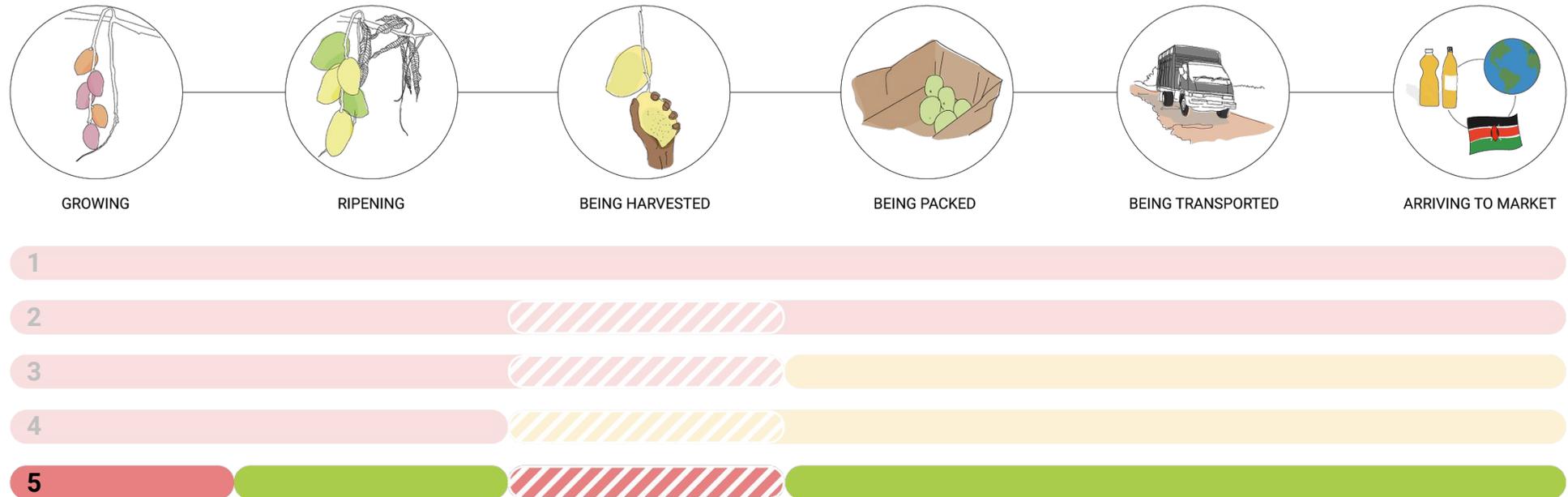
Relations between the main stakeholders and the main scenarios of the mango value chain



**Actor scenario number four** is similar to the previous one. However, the broker enters the value chain hiring his own labour for the harvesting. This gives the farmer less control of her income as she cannot ensure the quality of the harvested mangoes (and thus consequently the value of the mangoes for the broker), nor can she control the loss or rejections during grading. Putting all the negotiating power in the hands of the buyer.

# An overview: The main scenarios of the mango value chain

Relations between the main stakeholders and the main scenarios of the mango value chain



In the **fifth actor scenario** the farmer works together with the farmer organisation throughout the mango value chain. Still the maintenance of the orchard is carried out by the farmer, however the farmer organisation is the one dealing with the end buyer to create orders big enough for the member's collective. The chairperson of the organisation advocates for the farmers and aims to maximise mango unit price, however the farmers have usually no oversight during these negotiations. Commonly, as a consequence of the large orders, the farmer hires labour for the harvesting. After harvesting the mangoes are brought to a collection centre where the chairman meets with the end buyer and grades, counts and packs the mangoes. A part of the profit goes to the farmer organisation and the rest to the farmer, putting her in a position with less control and oversight into the negotiations and profit margins than if she controls the entire process on her own. However, the farmer organisation might be a stronger negotiating partner than a single farmer.

# The Customer Journey Map of the Farmer

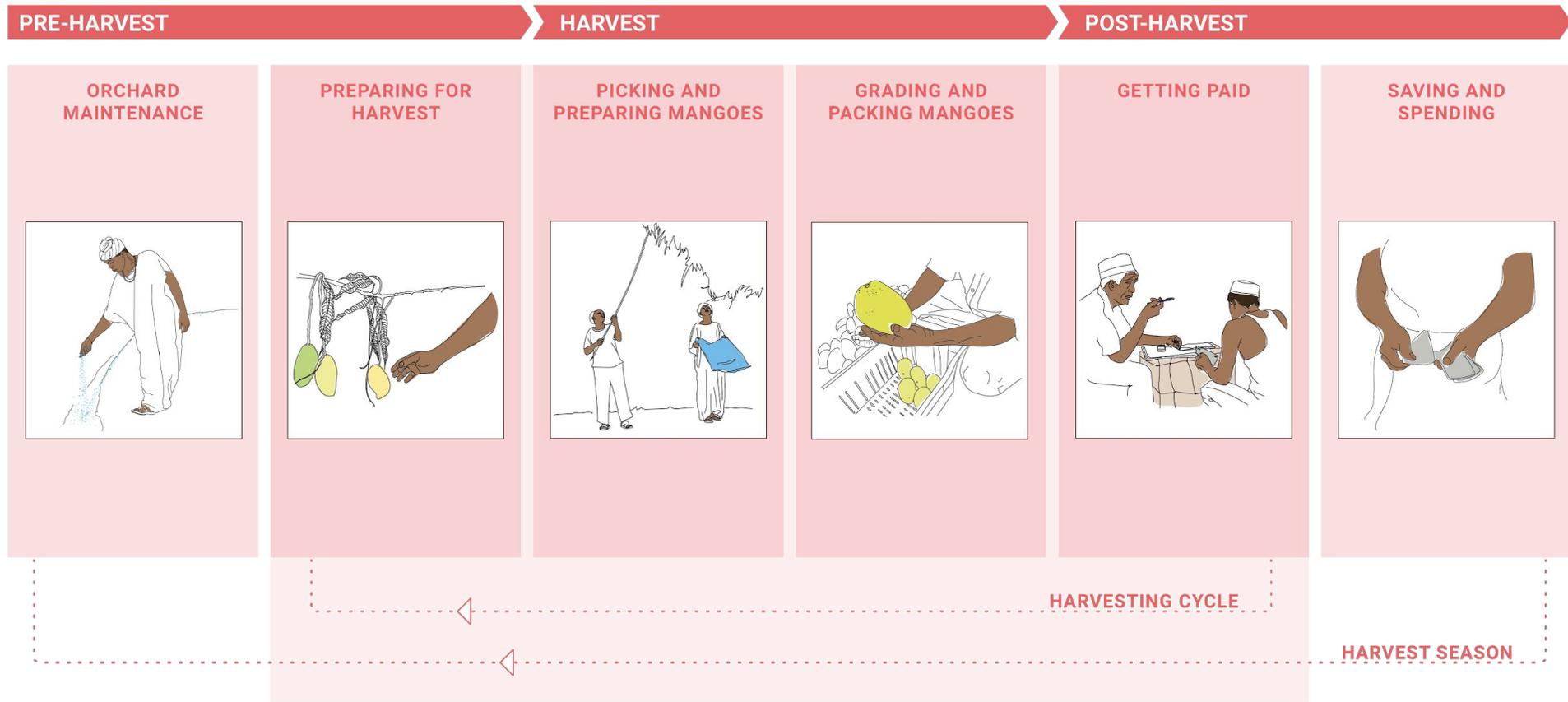
An illustrated view of a woman farmer's journey through the mango harvesting season in Kenya



The customer journey map illustrates the journey of the woman farmer through a mango harvest season. Each stage includes the different steps she is taking in order to make decisions and actions concerning her harvest, crop or farm. The journey is divided into three phases of **pre-harvest**, **harvest** and **post-harvest** and are supposed to help the reader locate where in the journey each stage is occurring and how it affects the journey. There are two loops visualised below the stages, showing how the harvesting cycle is repeated during a harvest season as well how as the harvest season is repeated throughout a year. On the following pages each stage is described individually with relating **actions**, **driving forces** and the **thresholds** experienced by the woman farmer.

# The Customer Journey Map of the Farmer

An illustrated view of a woman farmer's journey through the mango harvesting season in Kenya



# The Farmer Customer Journey

## ORCHARD MAINTENANCE

### What is happening in this stage?

Before, during and after the actual harvest season the farmer is constantly maintaining and looking after her orchard. Hence, this phase ranges throughout the whole year. For the farmer, this phase implies activities such as nurturing the mango trees with fertilizer before harvest, to ensure a healthy tree and good yield or putting up fruit fly traps around the time when the mangoes are egg-shaped, to catch the infectious fruit fly males around the orchard. Some farmers also prune their trees to enable more flowering and hence increasing the yield as well as simplifying the harvest. Another maintenance activity performed by many farmers is to bury or burn the broken and destroyed mangoes, decreasing the risk of pests. The amount of maintenance the farmer invests in her orchard depends on the resources she has available: knowledge, human/tool power, time and money.

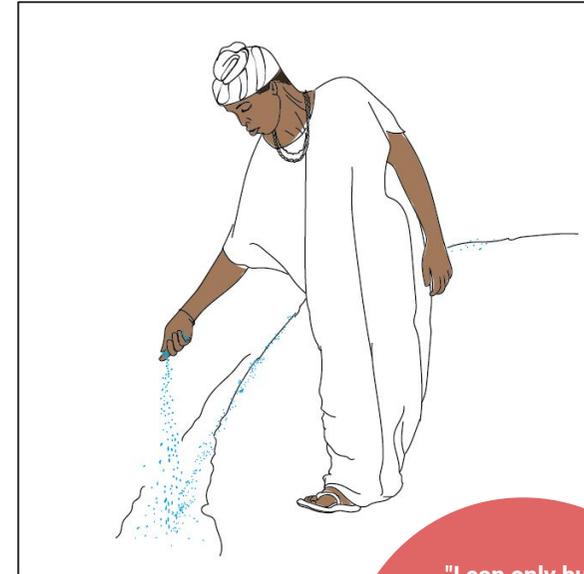
### What are the farmer's driving forces?

By nurturing and pruning the tree and avoiding pests, the farmer is striving for **minimised loss** of mangoes and **maximised yield** from each tree.

### What are the thresholds the farmer is facing in relation to the driving forces?

Weather conditions such as lack of rain, risk of drought or extreme temperatures directly affects the seedlings and the trees, and hence the yield. Another threshold is the high price of fertilizer and pesticides as well as the expiration dates of these products. A third threshold is that the available fruit fly traps only attracts male flies, leaving the female flies free to affect the orchard.

## ORCHARD MAINTENANCE



"I can only buy chemicals in large quantities. But since I'm not using all of it during one season it expires and goes bad."

# The Farmer Customer Journey

## PREPARING FOR HARVEST

### What is happening in this stage?

This is the period when the farmer prepares herself for harvesting and selling mangoes. That includes activities such as contacting local buyers (restaurants, hotels etc.) or brokers (find new or connect with established contacts) to set orders and negotiate price. This is often the first step, as a farmer very rarely harvests without an order. Together with the broker, or on her own, the farmer controls the ripeness of the mangoes to ensure the quantity and quality of the order. In certain areas the broker pays a deposit to the farmer before harvest, as security for the order. When farmers are organised in groups, the price negotiation with the broker is usually performed by the chairman of the organisation. The order is then split up into suborders and distributed among the farmers. In this phase the farmer also needs to ensure the labour for harvesting and transportation, if that is not catered for by the broker.

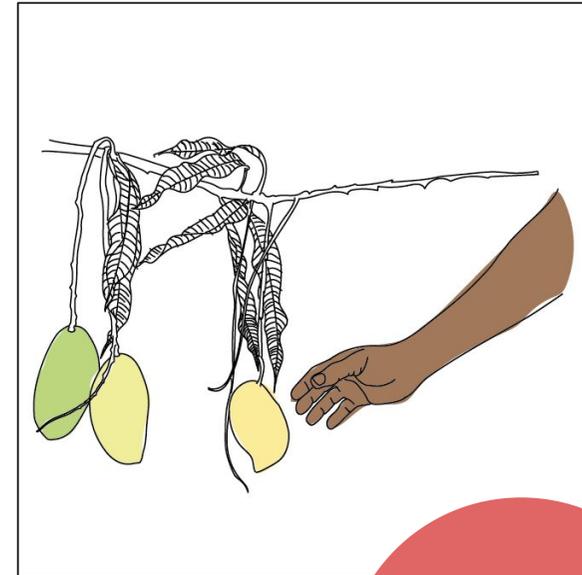
### What are the farmer's driving forces?

By assuring the quantity of mangoes and ensuring a sufficient amount of orders, the farmer is striving for **ensured** and **maximised profit** from their yield.

### What are the thresholds the farmer is facing in relation to the driving forces?

The most crucial thresholds are the ones concerning the farmer's relationship to the broker. For example, the advance payment of a deposit ties the farmer to one broker, putting her in a position where she cannot accept a higher price from someone else. Moreover, there are often more than one broker in between the farmer and the end buyer, decreasing the bargaining power of the farmer and hence the revenue. Sometimes the access to buyers are limited, due to weather conditions and poor road network.

## PREPARING FOR HARVEST



"There are many brokers between me and the end buyer... I don't know them and they eat my profit."

# The Farmer Customer Journey

## PICKING AND PREPARING MANGOES (1/2)

### What is happening in this stage?

During the actual harvesting period the farmer makes sure to harvest her mangoes according to order. Sometimes the farmer and her family harvest themselves, but more commonly it is the broker who brings his/her own harvesters or the farmer hires harvesters for the job. Usually under supervision and instruction from the farmer/broker, the harvesters work in teams and pick the mangoes in various ways depending on type of order and the conditions of the trees. For example, for the export market with higher demands on quality, mangoes are commonly picked one by one by hand or with a homemade harvesting tool. The harvesting tool lets the harvester pull down branches to reach mangoes or rip one mango at a time from the branch. For the local market and the processing industry, time and quantity are prioritised, hence more rough harvesting techniques are applied such as climbing the tree and throwing down the mangoes to a partner or even shaking the tree, often resulting in broken and bruised mangoes.

The next step is to prepare the mangoes for grading. In the case of the export market, this can be thoroughly done by placing the mangoes with the head down on the ground below the tree to let the sap run out, protecting the mango from stains. For the local market or processing industry this is done very rarely, instead the mangoes are left lying on the ground, occasionally on a nest of leaves, without any further preparation. Later the harvesters or the farmers pack the mangoes in crates or carton boxes and bring them to a gathering point at the farm.

## PICKING AND PREPARING MANGOES



# The Farmer Customer Journey

## PICKING AND PREPARING MANGOES (2/2)

### What are the farmer's driving forces?

By assuring the right quantity and quality of harvested mangoes as well as timely delivery and preparation of orders, the farmer's driving forces are to **maximise profit**, **minimise time consumption** and **minimise loss** from yield.

### What are the thresholds the farmer is facing in relation to the driving forces?

Many of the thresholds relate to loss of mangoes along the harvesting chain. For example, immature mangoes can sometimes fall down accidentally during harvesting, which are then of little or no value to farmer. Also bruising, breaking and thievery of mangoes due to ignorance or lack of knowledge by the harvesters lead to loss of income. Another threshold is the difficulty of transportation during rainy season, leaving the broker unable to reach the farm. This in turn leaves the farmer with over-ripened unsold mangoes. Another challenge relates to the harvesting of tall mango trees, forcing the harvesters to climb high up to reach the fruit. Not only does this increase the amount of time required to harvest, it also increase the danger of accidents. Time is also a challenge in the process of harvesting mangoes, where some harvesting techniques such as using a harvesting tool or picking one by one, consumes a lot of time. This puts the broker in a situation where he is able to collect fewer orders per working day. However, the time consumption is highly related to the quality of the mango, and therefore influences the grading and consequent price of the mangoes.

## PICKING AND PREPARING MANGOES



"I lose between 20-30% of my mangoes by fruits falling during harvesting..."

# The Farmer Customer Journey

## GRADING AND PACKING MANGOES (1/2)

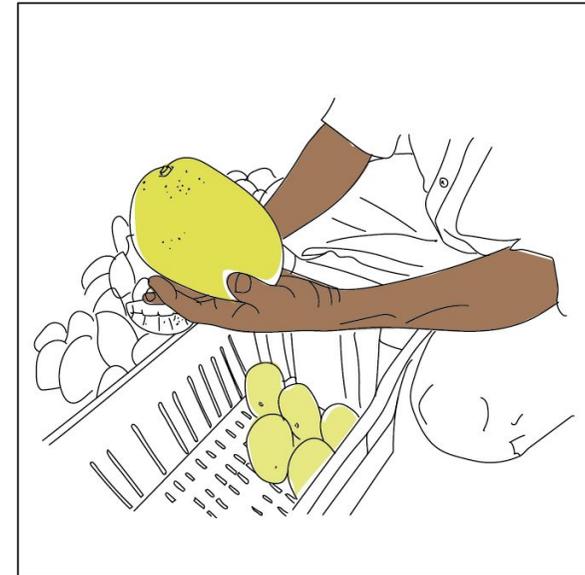
## GRADING AND PACKING MANGOES

### What is happening in this stage?

After harvesting the next step is to grade and sort the mangoes out by quality and size, which will affect the final price. This is done in various ways, depending of the context and market setting. For example, if the farmer is planning to sell her mangoes at the local market or at a collection point to a broker, she first grades them mangoes and then brings them to the marketplace in bags or cardboard boxes by bicycle, boda boda, etc.

When there is a broker involved, which is common, the broker grades and counts the mangoes according to his own grading system. This happens usually at the farm or at the collection point. There are different types of grading systems, all usually based on either quality, size or weight measurements, depending on market. For example, an order can be graded by size ranging from 8-13. Size 8 signifying that one crate fits 8 mangoes, hence the mangoes are big in size. On the contrary, size 13 would fit 13 mangoes in smaller size. A grading system based on quality is measuring and proving the grade by the colour, shape and texture of the mango, appearance of spots or marks etc. With this system, a broker could use a scale of 1-3, where 1 is best quality and hence given a higher price than grade 2 and 3. The mangoes that do not pass the grade are rejected by the broker.

After grading, the mangoes are packed. Commonly used packing material are cardboard boxes, crates and bags and often brokers bring their own preferred material. Sometimes the broker packs the mangoes directly into the trunk of his/her car or lorry. Rejected mangoes can be packed and sold at the local market by the farmer or used for home consumption.



# The Farmer Customer Journey

## GRADING AND PACKING MANGOES (2/2)

## GRADING AND PACKING MANGOES

### What are the farmer's driving forces?

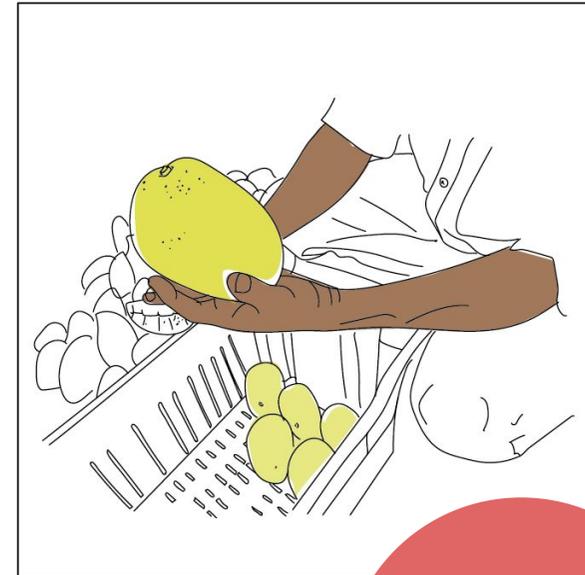
By assuring to get paid for all harvested mangoes and decrease the cost of transport, the farmer strives for **maximised profits**, **minimised losses** and **minimised costs** during this phase.

### What are the thresholds the farmer is facing in relation to the driving forces?

The biggest threshold in this phase is the misalignment in power between the farmer and the broker. At the point of sale, if the broker rejects the fruit then all potential income is lost.

During grading the broker has all the power of choosing or rejecting the harvested mangoes. For the farmer, it is hard to argue with the broker due to the risk of losing the whole order. Farmers expressed concerns that brokers tend to cheat during the counting and grading of the mangoes. Also, the size of the boxes and the lack of standard packing materials creates an opportunity for cheating. Furthermore, it increases the risk of breaking the mangoes in transport leading to losses at the collection point.

Another threshold for the farmer is the concern that a particular farmer can acquire a reputation for poor quality mangos among brokers, something that can result in a decreased future orders.



""I notice that the broker cheats in the grading, but what can I do?""

# The Farmer Customer Journey

## GETTING PAID (1/2)

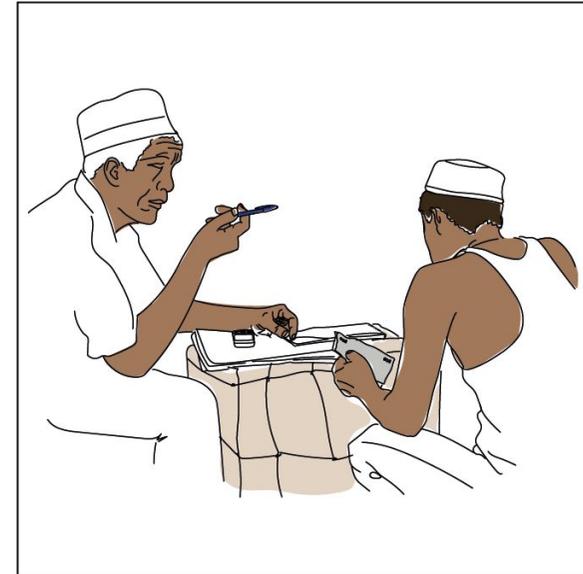
## GETTING PAID

### What is happening in this stage?

After grading and packing is done, the farmer gets paid by the broker. The price is based on the negotiations done prior to the harvest, between broker and farmer and then updated by issues concerning quality. Usually the price agreement is set to individual mango pieces, but occasionally by kilogram weight. The total price is calculated independently by the broker, assessing the grading of the fruit and the negotiated price. The farmer has little opportunity to interfere or control this calculation. Hence, she is simply given the sum calculated by the broker. If the farmer was paid a deposit, the remaining part of the price of the order is paid by the broker after calculation. On the occasions that the farmer hired labour for harvesting and/or transport she now pays her labour with the money received for the order. The rejected mangoes from the grading are taken back to the farm for home consumption or sold at the local market where possible.

### What are the farmer's driving forces?

By attempting to reach best price possible, lower the costs and benefit from the rejected mangoes the driving forces of the farmer are to **maximise profit** and **minimise loss** from each order.



# The Farmer Customer Journey

## GETTING PAID (2/2)

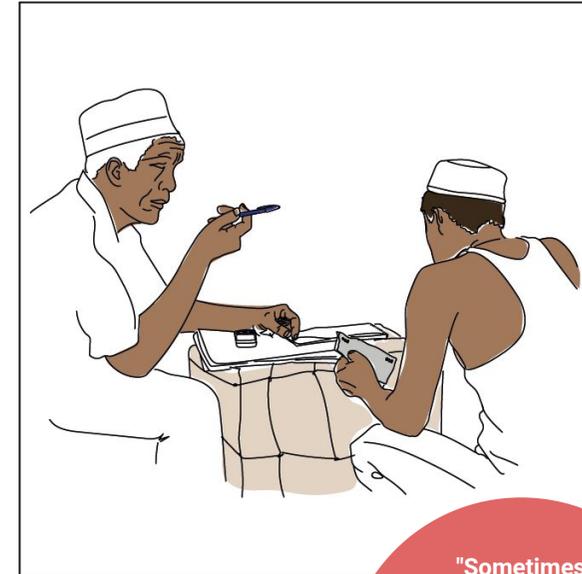
### What are the thresholds the farmer is facing in relation to the driving forces?

Again, the biggest threshold here is the misalignment in negotiation power between farmer and broker putting the farmer in a position where she risks losing money. In the price calculation the broker possesses the knowledge and power to set a price, well aware of the fact that the farmer needs to sell her harvested mangoes before they are spoiled. In cases where the farmer is given a deposit pre-harvest, she is obliged to sell the mangoes to the broker no matter what the final price settlement. Conversely, from the broker's side the verbal contract between the farmer can easily be breached. Also, farmers express concerns around the fact that brokers pay them a price for a low-quality market and then resell to a high-quality market for a higher price.

Another challenge, in relation to the driving forces of the farmer, is one of inadequate knowledge in value addition of rejected mangoes. Today, it leaves the farmer to either consume the rejected fruit at home or, in some cases, bring them to the market in hope for a small profit after paying the cost of transport.

Finally, the nature of fluctuating prices was stated by farmers to be a challenge throughout the harvest season. In comparison to other crops, where harvesting is done repeatedly throughout the year, the mango harvest seasons take place only 1-2 times per year. This results in high prices in the beginning of the season and low prices in the end, challenging the farmer to plan ahead for costs and income.

## GETTING PAID



"Sometimes the broker changes the price and gives me less than what we agreed on. But I would rather sell my mangoes at a low price than not selling at all."

# The Farmer Customer Journey

## SAVING AND SPENDING (1/2)

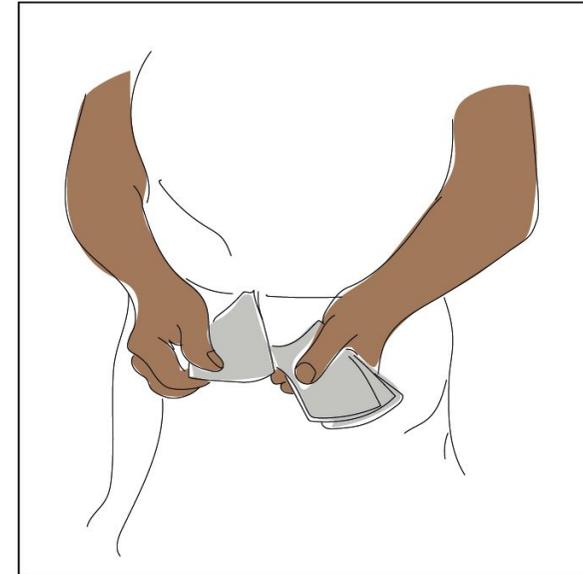
### What is happening in this stage?

Throughout the year as well, as during the harvesting season, the farmer attempts to keep track of her income, recording the revenue and the costs of her business. Income is generated from various sources, however for many families mangoes are one of their major income generating activities. The earnings are usually allocated to different household costs: savings, donations, loans and investments, etc. For example, most farmers prioritize the necessary everyday costs first, such as school fees for their children's education, food for the family, cellphone credits, rent for farm, etc. For the farmers who can keep savings, these are mostly kept individually for emergencies. However, in some cases a group of farmers join into a savings group for more security and long-term investments. Investments that are done repeatedly are often spent on fertilizer for next season's crop or on other maintenance activities on the farm. Some farmers also lend money to neighbours, friends or farmer group members in need.

### What are the farmer's driving forces?

By being aware of her income and trying to spend her money wisely on, above all, necessary costs and value-creating investments, the farmer is striving to **maximise profit** and **ensure secure investments** from her income.

## SAVING AND SPENDING



# The Farmer Customer Journey

## SAVING AND SPENDING (2/2)

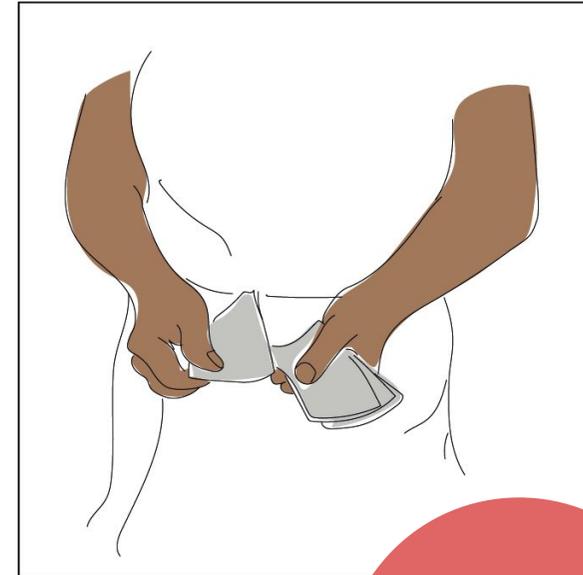
### What are the thresholds the farmer is facing in relation to the driving forces?

The thresholds in this phase of the customer journey varies greatly. One challenge is the low profit margin of mango production for the farmer, resulting from low unit price as a consequence of the market and her lack of power to influence prices. This limits her ability to invest in technology or other business prospects, as she instead prioritises saving money for emergency expenses. The costs of investing in technology are high, both in terms of capital expense but also in transition costs as they require new knowledge and experience. Generally this means that farmers do not view an investment in technology as having a marginal gain for them. However, some farmers acknowledge the need for storage facilities as a means to reduce spoilage and potentially increase their negotiating strength.

Another example of a threshold is that members of savings groups or farmer organisations sometimes experience difficulty in accessing their part of the common capital or revenue saved. The process of accessing their share implies that the farmer has to ask for permission from the board and clearly declare why and for what the money will be spent on, which can sometimes be socially problematic.

A third example of a challenging situation is when friends, neighbours and group members come and ask for a loan from the farmer, well-aware of the fact that the farmer has sold mangoes and hence has capital to share. In this situation the farmer usually offers a loan to her friend, purely out of courtesy and good will. However, often she later struggles to get refunded within a timeframe she prefers.

## SAVING AND SPENDING



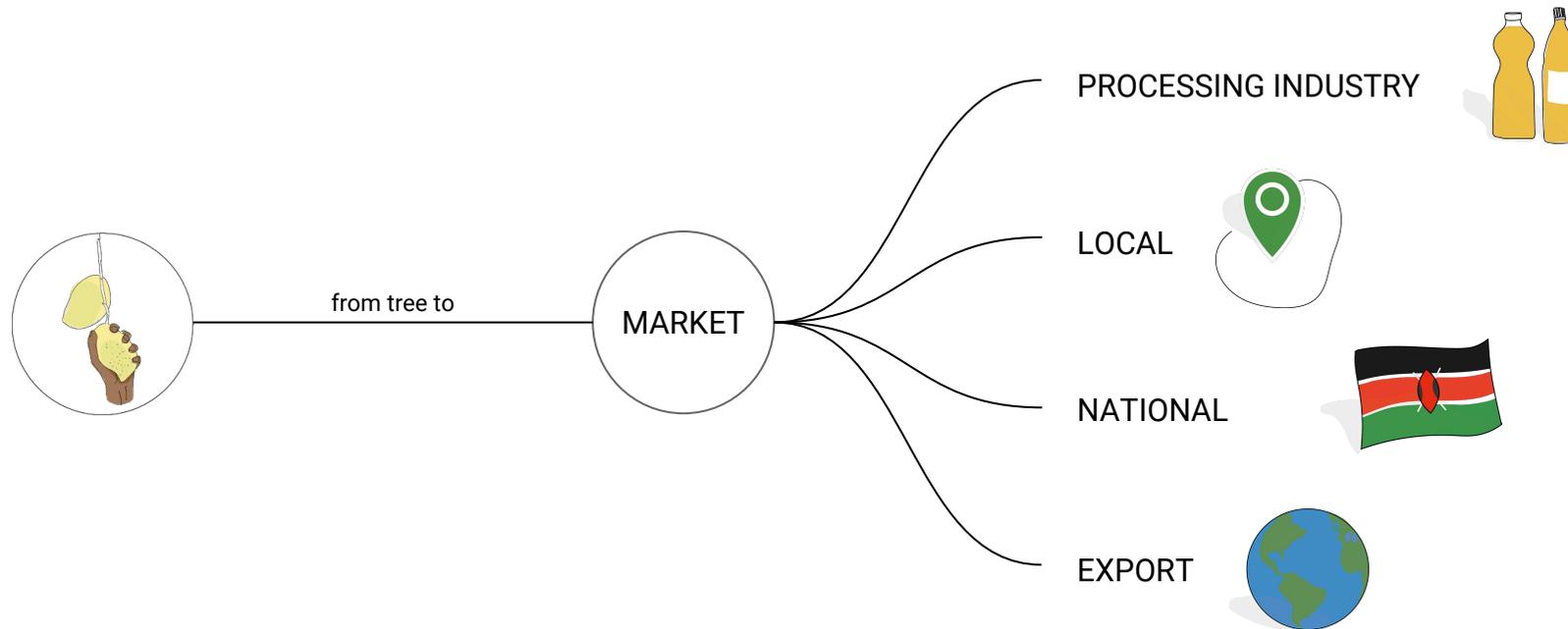
"My neighbours know that I have money because they've seen the broker here... So they come and borrow from me."

# **5 | Mango market structure**

- Pathways to markets

# Mango market structure

The main market pathways in the mango value chain in Kenya



In the field we observed four major market pathways for mangoes;

- 1) **Processing industry:** mangoes are processed into juice, concentrate or other value addition products. This was the largest market in our observations.
- 2) **Local market:** Mangoes are sold at street market stalls. This market pathway is the most accessible to the farmers.
- 3) **National market:** Mangoes are sold to end buyers, most commonly via a broker. Sometimes sold to local/regional restaurants.
- 4) **Export market:** Mangoes are sold to end buyers, most commonly via a broker.

On the following page the predominant factors for each market are pointed out, from the perspective of the farmer. These factors affects the farmers ability to increase her income, her consideration for investment as well as the impact of the shortlisted technologies and value addition products.

# Mango market structure

The main markets in the mango value chain in Kenya



## PROCESSING INDUSTRY

- Quantity of mangoes important
- High transport costs
- Access often depends on broker > less control for farmer on mango price
- Low price for mango (due to broker's negotiating power)



## LOCAL < 20 km from farm

- Quantity of mangoes important
- Easy access for farmer - lower transport costs
- Low price for mangoes (due to saturated market)



## NATIONAL > 20 km from farm

- Quantity and quality of mangoes important
- Quality and maturity important when sold to restaurants
- High transport costs
- Access often depends on broker > less control for farmer on mango price
- Low-medium price for mangoes



## EXPORT

- Quantity and high quality of mangoes important
- High transport costs
- Access often depends on broker > less control for farmer on mango price
- Highest price for mangoes

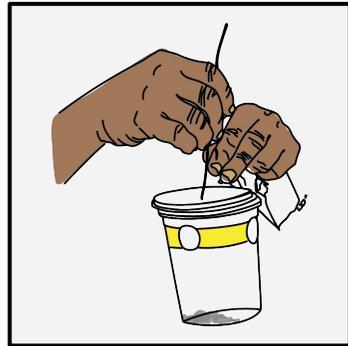
# **6 | Shortlisted technology breakdown**

- **Thresholds, benefits and preferred ancillary systems**

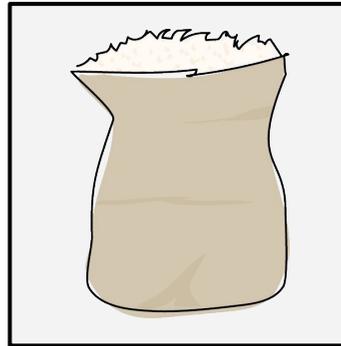
# Shortlisted technologies

Pre-harvest, harvest and post-harvest loss technologies for mango farming

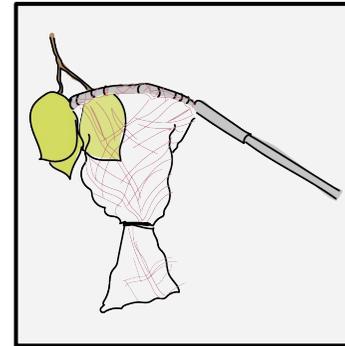
## Technologies used pre-harvest and during harvest



**Fruit fly trap**



**Fertilizer**

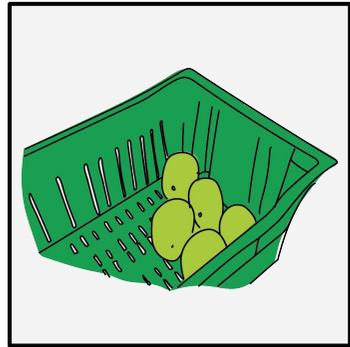


**Harvesting tool**

# Shortlisted technologies

Pre-harvest, harvest and post-harvest loss technologies for mango farming

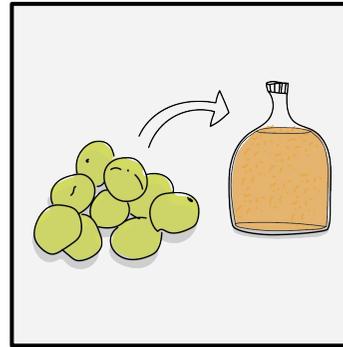
## Technologies used post-harvest and value addition products



**Crate**



**Cold storage**



**Mango pulping machine**



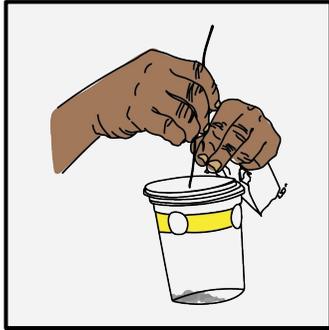
**Mango juice or concentrate**



**Mango fruit yoghurt**

# Technology Breakdown | Pre-harvest

Thresholds, benefits and preferred ancillary systems according to the farmers



**Fruit fly trap**

## — Thresholds

- Expensive for large farms
- Some neighbours don't have traps, decreasing the effect of the farms who have
- Trap only kills the males, females can mate with males from other farms
- 1 trap/20 trees (as stated) is not enough (1 per 5 trees is needed)
- Irritating smell
- Theft of fly traps
- Nausea because of the active chemical
- Some farmers don't replace trap when it expires

## + Benefits

- Can see results (flies in the can)
- The evident result (dead flies) gets farmers interested
- Cheaper way to kill fruit flies compared to other pesticides
- Can use less pesticide spray because of fruit fly trap
- Long lasting
- Requires little knowledge of usage
- Helps improve productivity
- Less spoilt mangoes, quality and quantity
- Not affected by weather
- No need to replace the outer case of the traps

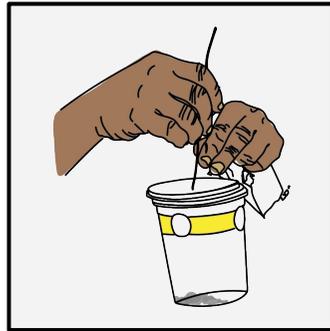
## ! Ancillary systems

- Collective Purchasing: Prefer to buy as a group because when other farmers don't use the trap it won't be effective
- Cheaper and easier
- Depending on the strength of the (farmer)group they can contribute, give loans to the farmers or give the traps for free to the farmers
- Distributors, such as: Technoserve, Agrovets, farmers centres
- The price that the farmers are comfortable with is 100 KSh

*"Some neighbour farmers don't bury the dead flies, thus their eggs can easily develop into new flies."*

# Technology Breakdown | Pre-harvest

Summary of observations and analysis from the research team



**!** **Ancillary systems**

- Possibility of collective purchasing to lower price and make pest control more efficient



## PROCESSING INDUSTRY

### + Benefits

- Helps improve productivity (quantity)
- Less spoilt mangoes

### — Thresholds

- Expensive relative to the profit of the mangoes sales



## LOCAL < 20 km from farm

### + Benefits

- Helps improve productivity (quantity)
- Less spoilt mangoes

### — Thresholds

- Expensive relative to the profit of the mangoes sales



## NATIONAL > 20 km from farm

### + Benefits

- Helps improve productivity (quantity)
- Less spoilt mangoes



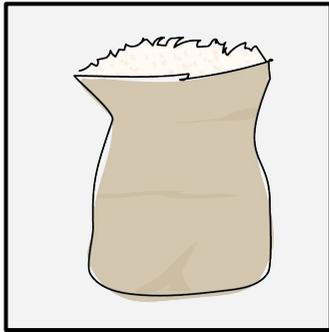
## EXPORT

### + Benefits

- Helps improve productivity (quantity)
- Less spoilt mangoes

# Technology Breakdown | Pre-harvest

Thresholds, benefits and preferred ancillary systems according to the farmers



**Fertilizer**

## — Thresholds

- Not organic
- More expensive than cow manure
- Mangoes can break when using fertilizer, because they grow too fast
- Lack of knowledge of application
- Lack of protective gears
- The soil is rich so need for fertilizer is questioned
- Expensive
- The farmer has to know that the investment pays off
- The fertilizer can change the pH of the ground
- Doesn't retain fertility of the soil as long as manure does
- Will not be effective for as long as cow manure

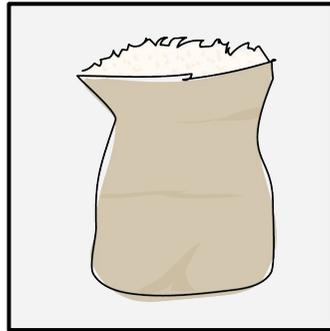
## + Benefits

- Increased productivity
- Works also during rainy season, manure only for dry season
- Farmer experience that the fruits are larger with the use of fertilizer
- Will have a faster effect than cow manure

*"It is tiresome to dig trenches for application"*

# Technology Breakdown | Pre-harvest

Summary of observations and analysis from the research team



## PROCESSING INDUSTRY

### + Benefits

- Helps improve productivity (quantity)

### — Thresholds

- Expensive relative to the income generated from the mangoes sales
- Free alternatives available (manure)



## LOCAL < 20 km from farm

### + Benefits

- Helps improve productivity (quantity)

### — Thresholds

- Expensive relative to the income generated from the mangoes sales
- Free alternatives available (manure)



## NATIONAL > 20 km from farm

### + Benefits

- Helps improve productivity (quantity)

### — Thresholds

- Free alternatives available (manure)



## EXPORT

### + Benefits

- Helps improve productivity (quantity)

### — Thresholds

- Free alternatives available (manure)

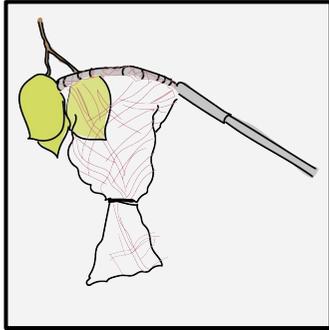


## Ancillary systems

- Possibility of collective purchasing to lower the price

# Technology Breakdown | Harvest

Thresholds, benefits and preferred ancillary systems according to the farmers



**Harvesting tool**

## — Thresholds

- It is non selective when picking a bunch of fruits
- Sap will spread on mangoes in the net (if you pick 2 at a time)
- Net collects the sap
- Too long
- Tiresome
- Demands for a lot of labour during harvesting season
- Handle is heavy
- Slow for harvesting esp. large orders
- Handle can break and net can tear up
- Expensive

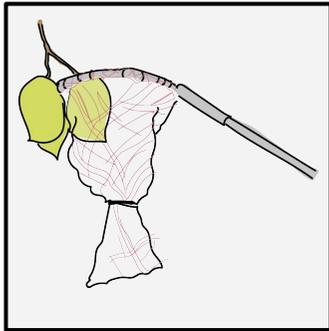
## + Benefits

- You can pick on your own (one person)
- Adjustable pole would be good
- Prevent damage from fruit falling during harvesting
- Results in good quality mangoes for market

*"The tool makes it difficult to pinpoint one single fruit in a bunch."*

# Technology Breakdown | Harvest

Summary of observations and analysis from the research team



## PROCESSING INDUSTRY

### + Benefits

- None

### — Thresholds

- Quality unimportant
- Slow to pick large quantities
- Expensive relative to the profit of the mangoes sales
- Highly uncertain that efforts will result in higher mango price from broker



## LOCAL < 20 km from farm

### + Benefits

- None

### — Thresholds

- Slow to pick large quantities
- Expensive relative to the profit of the mangoes sales



## NATIONAL > 20 km from farm

### + Benefits

- Prevent fruit getting damaged during harvest

### — Thresholds

- Slow to pick large quantities
- Highly uncertain that efforts will result in higher mango price from broker



## EXPORT

### + Benefits

- Prevent fruit getting damaged during harvest

### — Thresholds

- Slow to pick large quantities
- Highly uncertain that efforts will result in higher mango price from broker

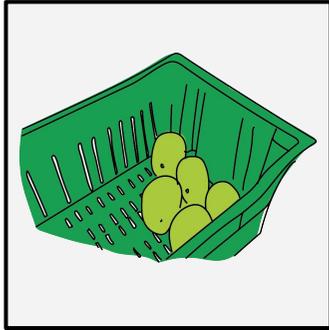


## Ancillary systems

- None required

# Technology Breakdown | Post-harvest

Thresholds, benefits and preferred ancillary systems according to the farmers



**Crate**

## — Thresholds

- Does not affect (low) price paid by broker
- Expensive: 700 KSh/crate
- Takes space and needs storage
- It hurts when you carry crates on shoulder
- Hard to carry many (instead one uses wheelbarrow)
- Have to re-pack into brokers boxes
- Branded
- Unavailable
- Reduces capacity of trucks if used for transport

## + Benefits

- Makes it easy to transport mangoes on farm
- Prevent damage to fruits
- Durable (can be used repeatedly)
- It allows aeration of mangoes during packing and transport
- Keeps mangoes safe during transport and storage
- Multipurpose - can be used for other fruits etc.

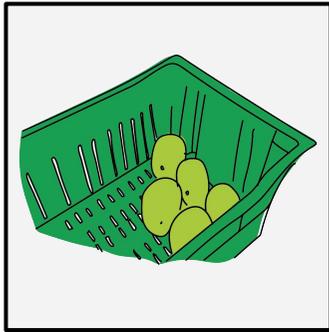
## ! Ancillary systems

- Farmers are willing to buy at 250 KSh/crate
- Farmers prefer to buy as a group because you can get a subsidised price if ordered in large quantities
- Make contribution as group members to buy together

*"I would need 200 crates for the mangoes on my shamba...it's too expensive."*

# Technology Breakdown | Post-harvest

Summary of observations and analysis from the research team



## PROCESSING INDUSTRY

### + Benefits

- None

### — Thresholds

- Quality unimportant
- Expensive relative to income generated from sale of mangoes
- Highly unlikely that efforts will result in higher mango price from broker
- Mangoes have to be repacked
- Takes space and needs storage
- Does not fit local transportation means



## LOCAL < 20 km from farm

### + Benefits

- Prevent damage to fruits

### — Thresholds

- Expensive relative to income generated from sale of mangoes
- Takes space and needs storage
- Does not fit local transportation means



## NATIONAL > 20 km from farm

### + Benefits

- Prevent damage to fruits

### — Thresholds

- Reduces capacity of trucks if used for transport
- Mangoes have to be repacked
- Highly unlikely that efforts will result in higher mango price from broker
- Takes space and needs storage
- Does not fit local transportation means



## EXPORT

### + Benefits

- Prevent damage to fruits

### — Thresholds

- Reduces capacity of trucks if used for transport
- Mangoes have to be repacked
- Highly unlikely that efforts will result in higher mango price from broker
- Takes space and needs storage
- Does not fit local transportation means



### Ancillary systems

- Recognised use and exchange scheme for crates involving both farmers and brokers.

# Technology Breakdown | Post-harvest

Thresholds, benefits and preferred ancillary systems according to the farmers



## Cold storage

### — Thresholds

- No access to cold storage during rains (due to muddy roads)
- Expensive and no availability
- Lack of electricity
- If owned by farmer organisation it needs to be big: 3 times the one on the picture
- As a group we can fit 2 crates per farm = too small, hence only useful if every farmer has a cold storage (too small for group)
- Cannot accommodate large quantities
- Lack of land or place to put
- Prone to theft
- Needs an expert to maintain
- Hard to reach for other farmers in the group
- Hard to plan use among farmers
- Uncertainty of electric power

### + Benefits

- The farmer avoids selling mangoes to processors who give poor price
- Not forced to sell at low price
- Safe and secure in spite of weather conditions
- Minimise mango waste
- Multi purpose: Can use for other fruits and crops when not mango season
- Keeps mango fresh
- Uses solar energy instead of electricity

### ! Ancillary systems

- Power supply needs to be stable
- If owned collectively, there needs to be a structure and agreement around usage, gaining all members
- Bigger cold storage facilities needed for farmer organisations
- Someone needs to be trained and instructed in usage and maintenance of machine

*"The mangoes get a second chance."*

# Technology Breakdown | Post-harvest

Summary of observations and analysis from the research team



## Ancillary systems

- Support and training of management committees
- Financing scheme for construction and purchasing of cold storage technology



## PROCESSING INDUSTRY

### + Benefits

- Keep mangoes fresh some extra days in case of broker having no access to farm (e.g. due to muddy roads)
- Provide extra time to aggregate harvest

### — Thresholds

- Expensive relative to income generated from sale of mangoes
- Too expensive for most single farmers
- Requires collective governance



## LOCAL < 20 km from farm

### + Benefits

- Keep mangoes fresh some extra days in case of having no access to farm (e.g. due to muddy roads)
- Provide extra time to aggregate harvest

### — Thresholds

- Expensive relative to income generated from sale of mangoes
- Too expensive for most single farmers
- Requires collective governance



## NATIONAL > 20 km from farm

### + Benefits

- Keep mangoes fresh some extra days in case of broker having no access to farm (e.g. due to muddy roads)
- Provide extra time to aggregate harvest

### — Thresholds

- Expensive relative to income generated from sale of mangoes
- Too expensive for most single farmers
- Requires collective governance



## EXPORT

### + Benefits

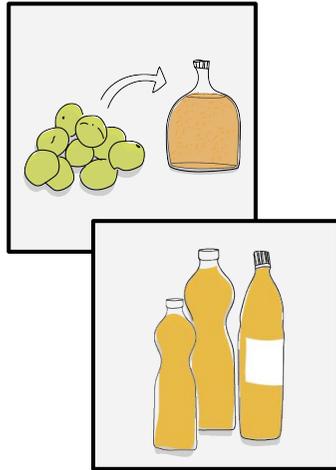
- Keep mangoes fresh some extra days in case of broker having no access to farm (e.g. due to muddy roads)
- Provide extra time to aggregate harvest

### — Thresholds

- Expensive relative to income generated from sale of mangoes
- Too expensive for most single farmers
- Requires collective governance

# Technology Breakdown | Value addition

Thresholds, benefits and preferred ancillary systems according to the farmers



**Mango pulping  
machine**

+

**Mango juice or  
concentrate**

## — Thresholds

- When it breaks it results in no flow of production
- Expensive purchase and repairing costs
- Unavailability
- No knowledge on use
- Manual machine since electricity is limited.
- Manual machine is tiresome
- Need certification to handle
- Save in savings group for 1-2 years
- It requires security
- Risk of having technical problems
- +
- Lack of market

*"I can preserve mangoes  
up to a year!"*

## + Benefits

- No need for electricity when machine is manual
- Farmers don't have to sell mangoes to brokers at low price
- Beneficial when owned as farmer group
- Enables a sustainable income
- Reduces waste/ rejects
- +
- Easier transport than fresh mango
- Better price than selling to processing industry
- Save money and crop because of no mango loss (juice from overripe mangoes)
- Buffer/ money off-season/spread income
- Better profit for juice than mango
- Farmer's believe there is a market
- Juice can be fed to children

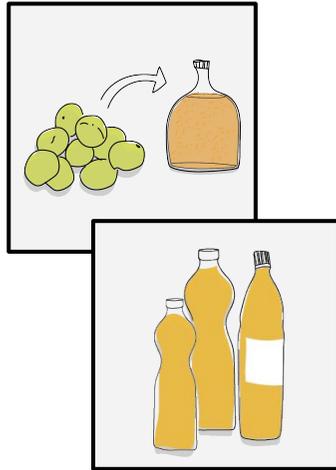
- Healthy because it is fresh
- Homemade juice is cheaper than buying from market
- The juice bottle can be used by children to carry water

## ! Ancillary systems

- To build a business you need more than pulping machine: plot, house, storage, containers, education, operators of the machine etc.
- Need to sell the idea to other farmers: Adding value, no waste etc
- Need to agree in a farmer group with many different opinions and needs
- +
- Need transport to reach far away markets
- Need to be many farmers (reliable juice resource) to create a market

# Technology Breakdown | Value addition

Summary of observations and analysis from the research team



PROCESSING  
INDUSTRY

## + Benefits

- Potential increase in value of harvest

## — Thresholds

- No current market for selling pulp/juice



LOCAL  
< 20 km from farm

## + Benefits

- Potential increase in value of harvest

## — Thresholds

- No current market for selling pulp/juice
- Have to create a new business
- Have to sell the idea to farmers group



NATIONAL  
> 20 km from farm

## + Benefits

- Potential increase in value of harvest

## — Thresholds

- No current market for selling pulp/juice
- Have to create new market and business
- Have to sell the idea to farmers group



EXPORT

## + Benefits

- Potential increase in value of harvest

## — Thresholds

- No current market for selling pulp/juice



### Ancillary systems

- Help the farmers to not only purchase and operate the machine, but to build a business around it.
- Help farmers to “pitch” the idea to farmers group

# Technology Breakdown | Value addition

Thresholds, benefits and preferred ancillary systems according to the farmers



**Mango fruit  
yoghurt**

## — Thresholds

- Broker/market usually prefers fresh mangoes
- Added cost of buying milk for yoghurt making
- No access to tap water
- Bigger challenge and risk the more ingredients to be co-ordinated
- Milk is difficult to access, no cows because of drought
- Market is not readily available
- Packaging containers are not readily available
- Needs very high maintenance
- Transport is expensive
- Lack of knowledge of procedure of making or ingredients source
- Requires storage areas for mango and final product
- Short shelf life

## + Benefits

- Value addition
- Use overripe mangoes instead of wasting them
- Can be sold locally in different quantities
- Does not require any machine to process

*"Yoghurt is good, it's a full meal. Like porridge."*

# Technology Breakdown | Value addition

Summary of observations and analysis from the research team



## PROCESSING INDUSTRY

### + Benefits

- Not applicable

### — Thresholds

- Not applicable



## LOCAL < 20 km from farm

### + Benefits

- Potential increase in value of harvest

### — Thresholds

- No current market for selling mango fruit yoghurt
- Difficulties in storage and preparation of multiple ingredients
- Transport to market



## NATIONAL > 20 km from farm

### + Benefits

- Potential increase in value of harvest

### — Thresholds

- No current market for selling mango fruit yoghurt
- Difficulties in storage and preparation of multiple ingredients
- Transport to market



## EXPORT

### + Benefits

- Not applicable

### — Thresholds

- Not applicable



### Ancillary systems

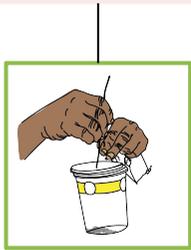
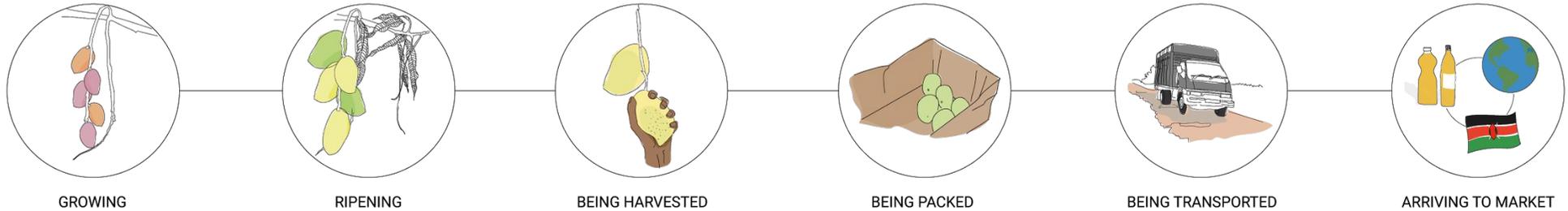
- Help in sourcing ingredients
- Training in preparation and storage of ingredients and products
- Marketing and business creation training

# **7 | Mapping the ecosystem**

- **The relations between the stakeholders in the mango value chain and the impact of technology**

# Mapping the ecosystem

Mapping the technology impact on the mango value chain from a farmer's perspective



FRUIT FLY TRAP

**!** If I want to sell to export market I need to make sure I have no fruit flies in my mangoes... otherwise I risk losing the whole order.

**-** It doesn't matter how many traps I buy - if the neighbours don't have any, mine won't have any effect anyway.

**+** They really work! You can see all the dead flies in the traps.

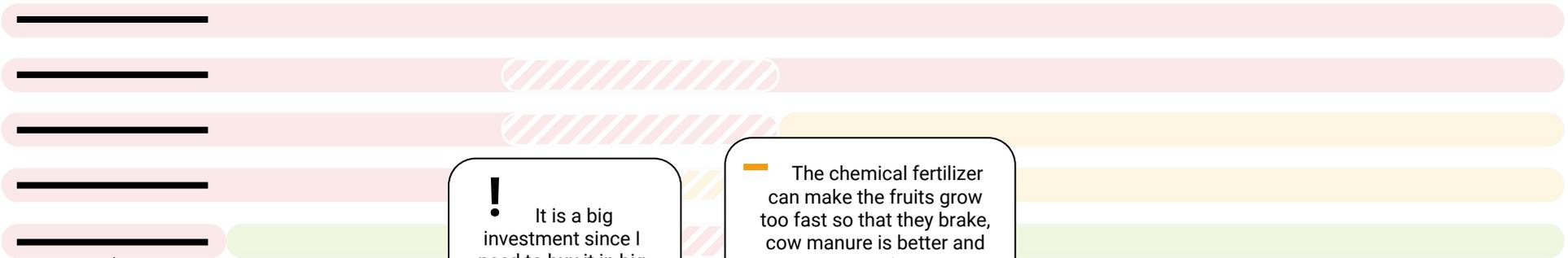
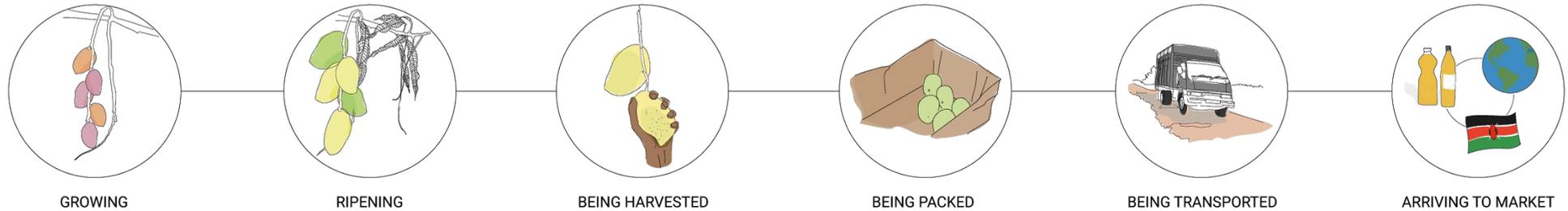
**+** Traps minimize the loss of mangoes, increasing the income from my mango trees.



Representations of the experience of the farmer

# Mapping the ecosystem

Mapping the technology impact on the mango value chain from a farmer's perspective



FERTILIZER

! It is a big investment since I need to buy it in big quantities.

— The chemical fertilizer can make the fruits grow too fast so that they brake, cow manure is better and organic.

+ Fertilizers increase the yield, so even if I have to sell at lower price to the local market or processing industry I still have a big quantity which increase my profit.

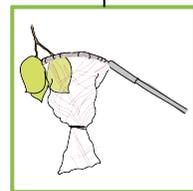
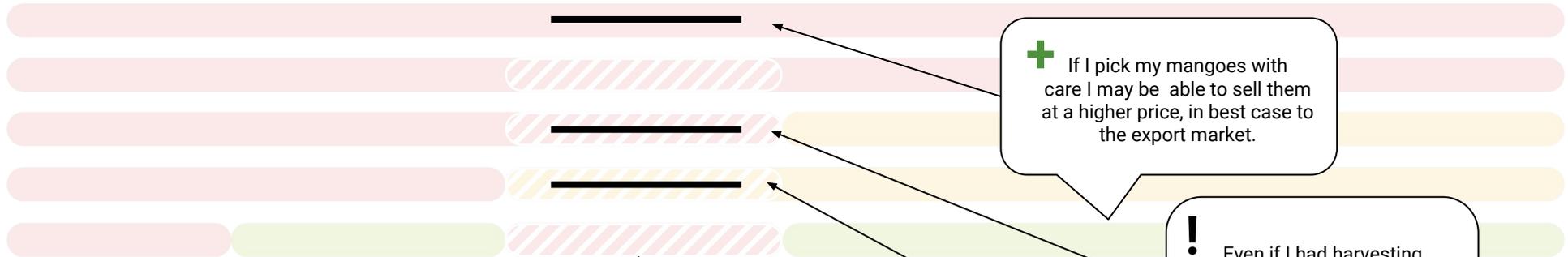
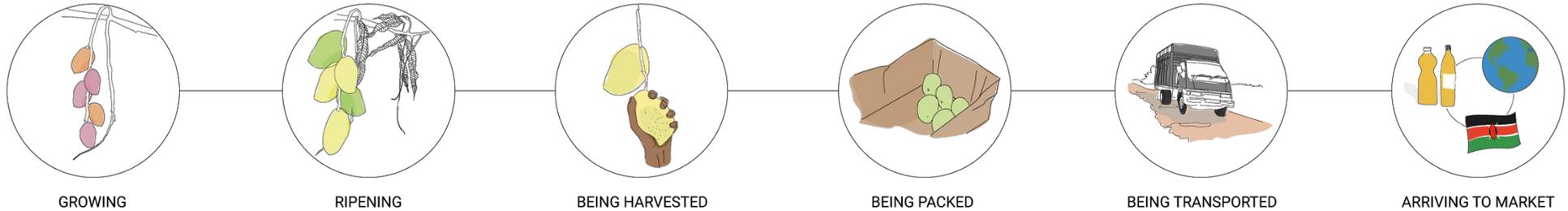
— Our soil is so rich here, we don't really need any fertilizer.



Representations of the experience of the farmer

# Mapping the ecosystem

Mapping the technology impact on the mango value chain from a farmer's perspective



HARVESTING TOOL

**+** If I pick my mangoes with care I may be able to sell them at a higher price, in best case to the export market.

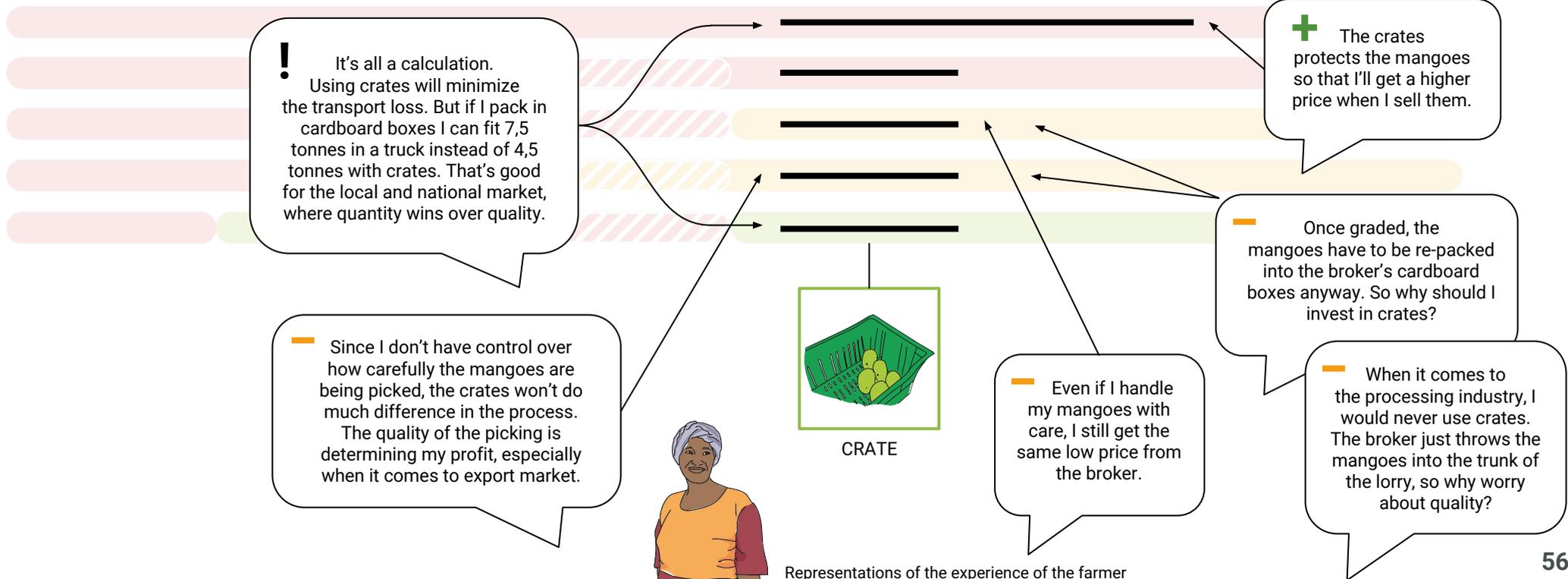
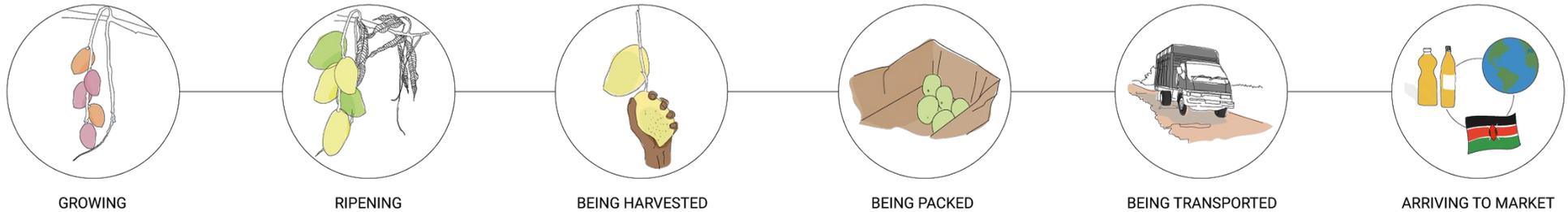
**-** The brokers and his harvesters don't care if my mangoes get spoiled. In the end, the broker only pays me for the fruit he can sell to the market anyway.

**!** Even if I had harvesting tools, I would still need to make sure that the harvesters use them. They just want to get the job done quickly and this tool does not enable that.



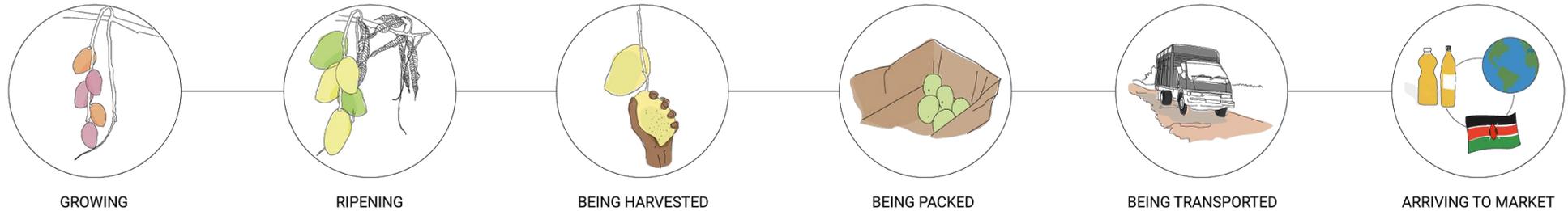
# Mapping the ecosystem

Mapping the technology impact on the mango value chain from a farmer's perspective



# Mapping the ecosystem - *future scenarios*

Mapping the technology impact on the mango value chain from a farmer's perspective



It is too expensive for me to buy alone and too small for us as a farmer organisation to accommodate all our mangoes.

The cold storage would only buy me a couple of days... mango price would probably still be low when I have to sell.

! If we would invest in a cold storage together in the farmer organisation, there would still be problems remaining: where to keep it, who will maintain it, how much storage space for each farmer, power source...?



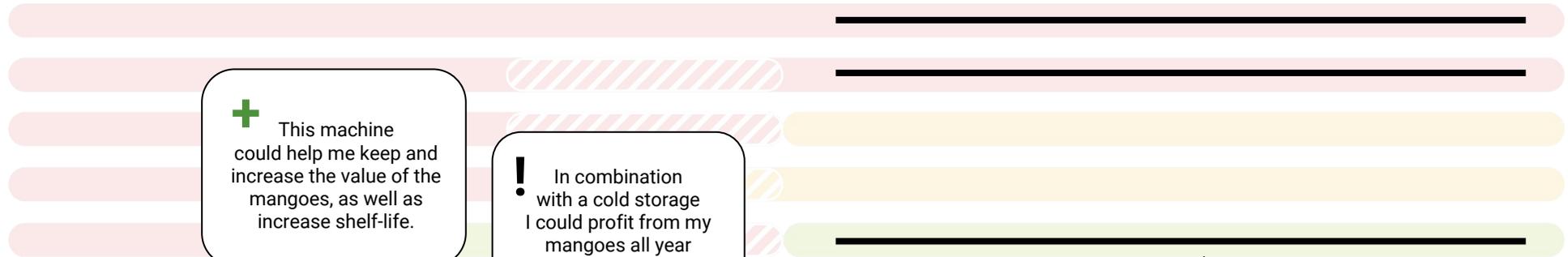
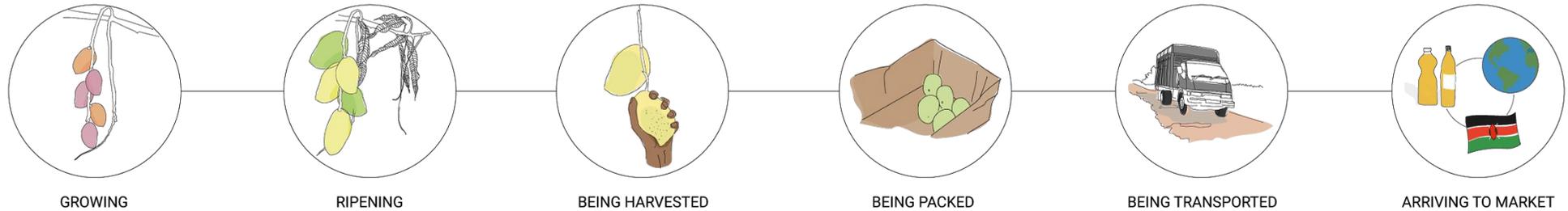
COLD STORAGE



Representations of the experience of the farmer

# Mapping the ecosystem - *future scenarios*

Mapping the technology impact on the mango value chain from a farmer's perspective



**+** This machine could help me keep and increase the value of the mangoes, as well as increase shelf-life.

**!** In combination with a cold storage I could profit from my mangoes all year around.

**+** With this technology we could, as a farmer organisation, pass by the broker and sell directly to the processing industry - or even start our own!

**!** The technology is not enough, we need to build a business and create a whole new market.

**-** It is expensive, we would have to invest in it together and agree on a way to share the use and maintenance.



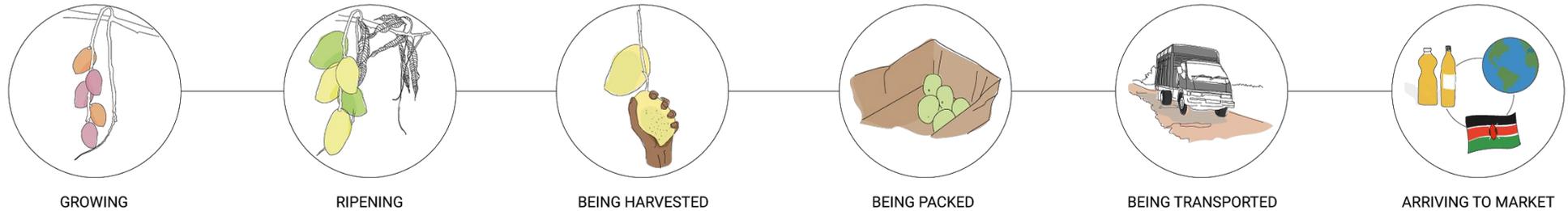
MANGO PULPING MACHINE + MANGO JUICE OR CONCENTRATE



Representations of the experience of the farmer

# Mapping the ecosystem - *future scenarios*

Mapping the technology impact on the mango value chain from a farmer's perspective



— If I produce yoghurt, don't I need to store it in a cool place?



— Is there even a market for this?



MANGO FRUIT YOGHURT

Representations of the experience of the farmer

# **8 | Recommendations and final notes**

# Recommendations and final notes

**Farmers feel little control over influencing the end price** - Farmers perceive that they have little bargaining power selling mangoes and that it is the brokers in the end who will determine the ultimate price. This influences the farmers' interest in investing in harvesting technology since it is seen as only benefiting the brokers. Many farmers think that bypassing the brokers would help farmers to feel more in control of end prices.

**Quantity not quality is the main mango farming strategy today** - The majority of mangoes are sold to brokers to service the processing industry. As such, many farmers believe that higher quality mangoes may still not yield a higher price from the brokers the main farming strategy is increasing the quantity rather than the quality. A bigger harvest will at least generate a higher income even if sold at a low price. Transition to a quality based harvesting strategy will require that the market will reliably reward farmers for their increased costs and effort.

**Little interest in quality technology without a reliable quality market** - If you want farmers to target the export market and therefore invest and make use of quality enabling technologies, such as harvesting tools and crates, there must be accessible and stable market that rewards such capital investment. At the moment, even if the export market generates the highest price for the mangoes it is seen as risky and unreliable. For an investment in new technologies to make sense the perceived benefits (e.g. increased profit) have to outweigh the disadvantages (e.g. investment costs, risk of loss, etc.)

**There's a keen interest in more industrially advanced post harvest loss technology** - Many of the farmers we've encountered in this project have seen potential in post harvest technology. Mainly as a mean to bypass the brokers and increase the value of their mangoes. However there is currently little appreciation or knowledge of the difficulties in transitioning towards more complex industrial processes, engaging with new markets and building viable businesses.

**New post harvest technology means new possibilities but also challenges** - Technologies alone will not provide the desired outcomes in isolation. We believe that one has to think more holistically in order to make valuable and sustainable changes. Even though technology, such as a pulping machine and mango yoghurt production, is an important component to increase the value of the mangoes, one should support the farmers in everything surrounding the technology, e.g. funding, knowledge of how to run, maintain and use the technology, creating a sustainable business model, creating and reaching the market, etc. There are also significant challenges to be addressed in regards to developing manufacturing and processing systems at a farm-scale level; sourcing and storage of ingredients and products, maintaining quality assurance and hygiene, coordination of multiple agents in a marketing and sales team, etc. This means that although there are potential benefits, and these technological innovations were popular when presented, the practicalities of successfully implementing them will require significant further support to create an enabling environment. This support could be developed, tested and refined at a small scale together with farmers before scaling up.

# Recommendations and final notes

## **Alternatives solutions could further complement the post harvest loss initiative -**

We would suggest exploring complementary alternative solutions to aid farmers in harvesting and minimise losses. Some examples are presented below:

### *Grafting*

Grafting seedlings onto existing trees could combine the benefits of several technologies to improve outcomes for farmers. Seedlings are very cheap and can produce a commercial crop within three years. By an organised implementation of grafting schemes on farms the size of trees and their arrangement in orchards can be optimised to facilitate fast harvesting of high quality fruit. This could then change the cost-benefit ratio to encourage producers to invest in more farm-based technologies to specifically target national and export markets.

### *Transport service*

Transport, due to poor road conditions and expensive freight charges, continues to be a significant challenge to farmers. There seems to be potential to develop a *transport service* and establish contact between the farmers and the end buyers. By doing so that the farmers can deliver and sell their mangoes straight to the end buyer bypassing the brokers thus increasing the profit for the farmers. This could be coordinated through the establishment of a membership cooperative facilitated by micro-finance schemes.

### *National cooperative franchise*

Another possibility would be to look into developing a *national cooperative franchise* supporting farmers with for instance mango pulping machines to produce and sell mango juice. The national cooperative franchise would provide the technological expertise and business acumen to support local producers. For example, the franchise could be mandated to create and promote a national mango juice brand. So instead of each farmer creating their own local businesses, competing with the neighbours, they could become franchisee, producing and selling their mango pulp/juice directly to the national franchise cooperative. Through this mechanism the market for juice (or other products) by local producers could be expanded to target national, and potentially, export markets.

# Collaborating project partners:

UNWomen Eastern & Southern Africa  
[www.africa.unwomen.org](http://www.africa.unwomen.org)

Flavia Ciribello  
Jacinta Okwaro  
Åsa Torkelsson

Jomo Kenyatta University of Agriculture  
and Technology  
[www.jkuat.ac.ke](http://www.jkuat.ac.ke)  
Dr Daniel Sila

TechnoServe  
[www.technoserve.org](http://www.technoserve.org)  
Isaiah Kirema  
Goudian Kilemba  
Wilberforce Ntwiga

Expedition Mondial  
[www.expeditionmondial.se](http://www.expeditionmondial.se)

Erik Widmark  
Jenny Annebäck

Stockholm Environment Institute  
[www.sei-international.org](http://www.sei-international.org)

Matthew Osborne  
Ylva Ran  
Cassilde Muhoza  
Marie Jürisoo

