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# Factors influencing choice of post-harvest handling strategies for a horticulture and cash crop in Kibugu, Kenya

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Left: Kikai Foods' drying house for banana flour and crisps production. Right: Macadamia sorted in boxes for storage. Photos: Henriette Hansen.


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## Abstract

Post-harvest activities can add substantially to the final value of agricultural crops and be a driver for rural development. Consequently, changes in post-harvest handling practices have potential for reducing post-harvest losses and increasing farmers' income. This report looks at the factors influencing farmer decision on post-harvest strategies for a horticulture and cash crop in Kibugu, Kenya. Banana and macadamia, a horticulture and cash crop respectively, were chosen as the focus crops because of their significance in the area. A rational choice framework was applied to employ a cost and benefit analysis of farmers' decisions to choose a certain post-harvest strategy over another for each crop. For banana, the report looked at farmers' decisions on whether to add value to their banana production. In the case of macadamia, it studied farmers' choices to contract with a company, sell freely, or store macadamias. A number of influential factors from the external world, farm level, and the internal world of the farmer's individual characteristics were identified as driving farmer's expected costs and benefits decision process. The most significant factors influencing farmers' decisions on value addition were age, perception of risk, lack of information, and use of groups. In the case of macadamia, contract farming was used as mechanism to shield from the risk of price fluctuations. Although storage was introduced as a possible post-harvest handling strategy, there was conflicting information as to whether storage of macadamias was a viable alternative available to farmers.



Key words: Post-harvest handling, value-addition, cash crop, horticulture crop, rational choice.



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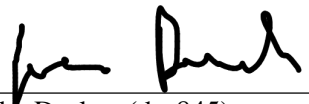

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Post-harvest & value-addition group members including interpreters. Photo: University of Nairobi.

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# Introduction

Post-harvest is an integral stage of the world agricultural systems. It comprises interconnected activities occurring after crop production, including transportation, storage, packaging, procurement, processing and marketing (Goletti & Samman, 2002). These activities can contribute up to 80% of the final value of the product, even for unprocessed foods like fruits and vegetables (Ibid). In developed countries, the economic value of post-harvest activities surpasses that of farming. Inversely, the post-harvest sector of developing countries is small, but has potential for expansion (Ibid). Adoption of post-harvest strategies can increase the value of the product farmers sell, connect farmers to local and foreign markets, and increase the demand for the raw materials farmers produce, thereby increasing farmers' living standards (Ibid).

An efficient post-harvest system can also contribute to food loss reduction throughout the value chain (Goletti & Samman, 2002). In sub-Saharan Africa, where more than 70% of the population depends on agriculture for income and consumption, post-harvest loss (PHL) is a major challenge undermining the food security of these millions of smallholder farmers (Abass et al., 2014). High PHL can be attributed to poor temperature management, handling damage, decay incidence, and market value loss (Saran et al., 2012). Specifically, in Kenya, a lack of adequate post-harvest handling (PHH) has led to average estimated PHL of 20-30% (Odongo, 2013). PHL incurs economic losses for farmers when losses in auto-consumed foods require farmers to purchase additional foodstuffs, or commercialized goods do not reach the consumer or retail levels. At the same time, PHH can determine the crop's quality and value and farmers' ability to sell their crop, influencing the revenue farmers receive for their crop (Kimiywe, 2015). Additionally, smallholders cultivate a diverse portfolio of crops that is highly variable within Kenya, requiring a requisitely complex set of handling technologies and techniques to prevent losses. Apart from a dearth of affordable PHL mitigation technologies, investment in improved processing and storage technologies in low-income countries is often either non-existent or insufficient (Ehui & Pender, 2003). In Kenya, lack of PHH trainings and development as well as neglect of post- harvest infrastructure are the main culprits (Kitinoja & AlHassan, 2012).

Post-harvest activities have enormous potential to mitigate PHL in rural areas, increase available food, and augment farmers' income (Hodges et al., 2011). However, different types of crops require different approaches. Grain, horticulture, and cash crop products' escalating degree of PHH complexity construct a spectrum for investigation. In sub-Saharan Africa, grains account for 41.9% of auto-consumed crops, therefore farmers do not stand to benefit as much from value-addition practices (Chauvin et al., 2012). PHH of grains is primarily concerned with losses from immediate PHH of drying and shelling (5- 8%) and storage (3-5%) (NRI, 2014). This low degree of PHH places grains at the left of the spectrum.

In Kenya, horticulture crops are occupying a rapidly increasing share of farmer's income. Commercialized horticultural products are often bound for Nairobi or foreign markets, incurring losses due to external pressures of greater quality selectivity (Colbert & Stuart, 2015). Additionally, multiple stages of storage and transportation raises the potential for losses. Horticulture crops can have PHL as high as 40-50%, detracting from farmer incomes (Datta et al., 2015; Toivonen et al., 2014). However, diverse utilization of the crop for auto-consumption and animal feed aids in mitigating some of these losses and provides potential for value-addition (Joshit et al., 2004). Horticultural products with their mix of in and ex situ processing and storage fall in the middle of the spectrum. This placement facilitates implementation of on-farm value-addition activities, transforming a crop into a product that can be sold for a higher price (Hodges & Bennett, 2011). Several methods can be used to add value to a crop including: packaging, drying, dehydration, pressing, preservation, and processing into solid and liquid forms (Sharangi & Datta, 2015). Drying and dehydration are low-cost methods that not only preserve the product, making it available throughout the year, but also decrease its transportation and handling costs by reducing its weight and often its volume (Seidu et al., 2012).

Cash crops like coffee and macadamia nuts are often processed off-farm in cooperative or company factories. The foreign export market almost exclusively determines demand for these crops, only 3% of Kenyan coffee is consumed domestically, leading to demand and, therefore, price volatility (Gitonga, 2015). While cash crops like macadamia nuts and coffee exhibit a more pronounced shelf life than horticultural products, the market, processing, and quality control create more stages of PHH down the off-farm value chain This requires a higher degree of coordination between the buyer and farmer to implement changes. As such, cash crops fall on the right of spectrum.

## Problem Statement and Research Question

The constructed spectrum of PHH within grain, horticulture, and cash crop products allows for categorical comparison in analyzing the factors that influence choice of PHH strategies. Given the variability in the degree of PHH at the different post-harvest value chain stages, a full value chain analysis would distract from a focus on farmer's choice of strategies. This, however does not preclude examining how reverberations along the value chain caused by different PHH strategies are felt at the farm level.

In order to compartmentalize the analysis, crops extensively cultivated in the research site and exemplar of their category were selected. Maize is the staple crop in the region and suffers high PHL, making it an ideal candidate for investigation. However, efforts to mitigate these losses and reduce farmer's risk of food insecurity through the introduction of specialized storage bags have been highly successful and extensively researched. PHL in maize, therefore, does not constitute the main focus of the investigation.

Bananas are cultivated on the overwhelming majority of farms surveyed in the research site and are both auto-consumed and sold commercially. The crop's value-addition potential can significantly add to income generation. Risk of absolute loss is low due to the different avenues available for banana use on-farm. Macadamia nut is the location's second most important cash crop, and the farmer's risk at the hands of buyers as well as surging prices, warrant further analysis. Divulging the factors that lead farmers to make the choice of PHH of these crops in the research site will determine the structures necessary for farmers to adopt new strategies that have the potential to ameliorate their livelihoods.

Given this logic, the research question of *What factors influence choice of post-harvest handling strategies for a horticulture and cash crop in Kibugu, Kenya* emerges. Several sub-questions further demarcate the bounds of the investigation: 1) *How do the expected benefits and costs affect this choice?* 2) *How does the nature of the crop that is being handled influence this choice?* 3) *How does the characteristics of the individual farmer influence this choice?* and finally *4) How this external factors influence this choice?*

## Rationale Behind the Analysis

Rational choice theory provides a starting framework through which to view the choices that farmers make. Assumptions are made that also serve as constraints of the framework: the agents making choices are themselves behaving rationally and these agents are operating in a world of perfect information. Such constraints also benefit the analysis in determining as to why certain actors do not choose that which is rational; the agents may not be behaving irrationally, but rather are not performing such choices under the assumptions (Green, 2002). Below is a framework of rational choice modified for the purposes of the research (Figure 1).

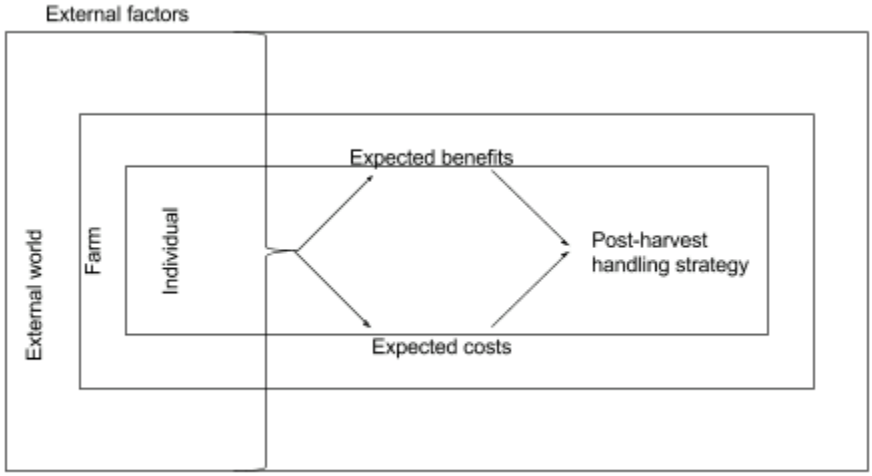



Figure 1: Rational Choice Framework (adapted from Ostrom, 1990).

The rational weighing of the expected benefits and expected costs of the strategy does not occur in a vacuum, therefore factors stemming from the individual, the farm, and from the outside world as well as their requisite interactions influence the agent's perception of these expected costs and expected benefits. These factors are common to the crops and cases studied, however their manifestations vary for each case study. Trends in how these influencing factors affect the rational choice of the farmer and the validity of the assumptions made through this rational choice framework are analyzed in the discussion.

Figure 2: *Map of Kenya depicting the location of Embu County* (from NordNordWest, https://en.wikipedia.org/wiki/Embu_County)

## Description of Field Site

Fieldwork centered around Ngerwe village and the larger Kibugu Location in Embu County, Kenya, located 120 km northeast of Nairobi (Figures 2, 3, and 4). Embu County lies on the southeastern flank of Mount Kenya. Ngerwe village lies in a valley backed by the Rupingazi River, with its headwaters on Mount Kenya, 2.5 kilometers south of Kibugu center. The local dialect, Kiembu is spoken by all residents, most of whom are fluent in Kiswahili, and many of whom speak basic English. Most of the inhabitants in Kibugu are Christians with the majority therein being Protestant with several Catholic congregations. Kibugu is a patchwork of ethnic Embus and Kikuyus. Over 70% of the population in Embu County are smallholder farmers (Embu County Government, 2016). The region has a tropical climate with an average annual temperature of 20.2°C and an average monthly temperature variation of 3°C. There are two distinct rainy seasons, one from March to June and another from October to December, which together contribute 82% of the 1120 mm of average annual precipitation (Climate-data.org, 2015). Changes in the pattern and intensity of rains has been documented and observed by locals in recent years and are attributed to climate change. Since the 1960s, the entire country has experienced a 1.1°C rise in average temperature (McDonnell, 2016).

The main cash crops cultivated in Kibugu are coffee, tea, and macadamia. The food crops are mainly maize, beans, banana, mango, kale, avocado, tomato, and passion fruit. Commercialized fruits and vegetables are becoming more common, and are beginning to replace coffee and tea. A more detailed typological farmer description follows in the results.

## Methods

Data was collected from March 2nd-12th, 2017 in the area of Kibugu Location, Kenya (Figure 2 & 3). Informal conversations and observations with locals were carried out at the primary stages of the data collection period to establish important ideas and themes for further investigation. Throughout the collection of data, general limitations included insufficient time and lack of language ability. The interviews were conducted in Kiembu or Swahili with the aid of the interpreter, or in English when possible. The risk of using an interpreter was the loss of information during translation. Although farmers were exceedingly accommodating in lending their time to answer our questions, interviews and questionnaires were conducted under self-enforced time constraints to avoid derailing farmers from their work.

## Questionnaire

Questionnaire-framed interviews conducted at the beginning of the fieldwork provided quantitative data on an overview of the extent of the issue of PHL and afforded an idea of the focus crops (Appendix 4) (Rea & Parker, 2014). By working together with three other research groups, a total population of 94 farmers was surveyed, this research group executing 20. The households were randomly sampled by approaching every third household along the road through each respective research group's area. Coordinates were mapped with Garmin GPS (etrex 10) at each farm where questionnaires were conducted (Figure 3). The informants were the head of the household. The questionnaire was conducted in 30-45 minutes, which was longer than expected. The prolonged time carrying out the questionnaires was mainly due to small-talk and need for translation.

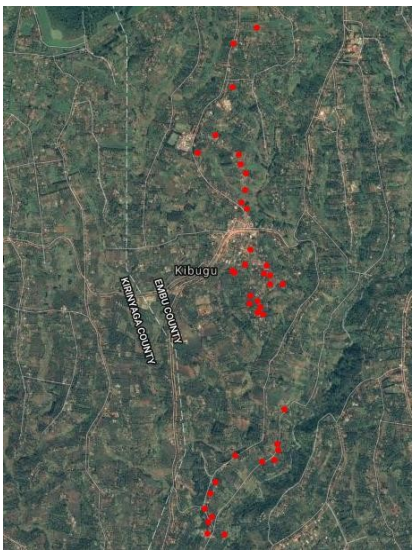



Figure 3: *Kibugu Location with questionnaire respondent distribution*

Based on the analysis of the quantitative data, a decision was made to focus on banana and macadamia as the main crops for investigation. Additionally, the data indicated potential candidates for further exploration through semi-structured interviews and PRA sessions. The analysis relied on the entire population of questionnaires, increasing the credibility and ability to see patterns in the survey.

## Informal Interviews

At the first stages of the data collection period informal interviews were carried out with several individuals. These included: 2 banana market sellers, 2 macadamia middlemen, 1 miller and various

individuals in the local market and at the Embu Agricultural Show. These interviews provided an overall perspective of the area, crops grown and sold, and issues faced by farmers. The data obtained also helped to inform the guiding questions for the semi-structured interviews.

## Semi-Structured Interviews

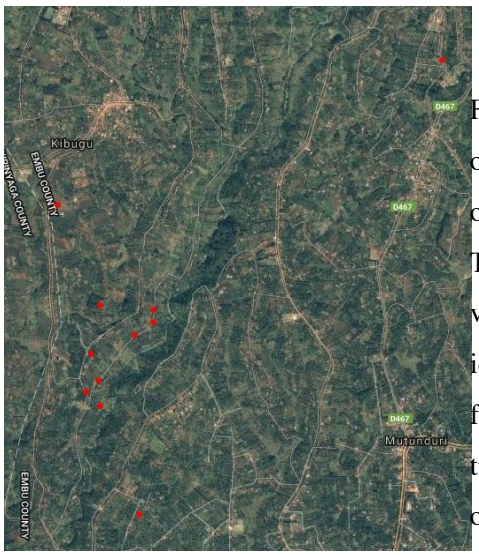



Figure 4: *Detail of locations of SSIs locations centered in Ngerwe* (created with Map data ©2017 Google)

A total of 15 semi-structured interviews (SSI) were conducted. First, 3 SSIs were carried out with key informants: a post- harvest officer for Kibugu, agribusiness officer for Kibugu, and field officer for a macadamia processing company (Jungle Nuts). These interviews afforded an outsider's perspective of banana value-addition and macadamia production and helped to further identify key themes and issues to address when interviewing the farmers. The information thus obtained was also used to triangulate with that of farmers. The second set of SSIs consisted of a group of 12 farmers divided in 4 four groups: 3 macadamia farmers contracted by a macadamia processing company, 3 non-contracted macadamia farmers, 3 banana farmers doing no value-addition, and 3 banana farmers doing value-addition (Figure 4; Appendix 5). These groupings allowed for comparison of farmers' decisions for adoption of post-harvest handling strategies of either banana or macadamia and the constraints and risks they faced. The interviews lasted 30-60 minutes and were guided by a set of questions (Appendix 6) inspired by a questionnaire on value chain assessment (MEDA, 2011) and post- harvest food losses (FAO, 1980) as well as information from observations and informal interviews.

## Participatory Rural Appraisal

Participatory rural appraisal (PRA) methods were employed to gain a better understanding of the farmer's perspective of the post-harvest process and value-addition in Kibugu. Seasonal calendar and ranking exercises were done with banana and macadamia farmers as part of the SSIs. The later clarified importance of the different crops and what they are used for, while the former delineated at when during the year the workload was heavier and whether value-addition is possible for the farmer given the time they have available. The Venn diagram was used in the SSI interviews with 2 of the farmers engaged in banana value-addition to enumerate their different stakeholders and clarify the importance they attribute to the actors in the production, marketing and distribution stages of their network (Robinson, 2002).

## Participatory Observation

Participatory observation was conducted on all farms visited during the fieldwork. Living with local families in the community afforded insight into their everyday life, living situation and conditions and helped build trust and mutual respect. The direct participatory actions were limited to taking part in a meeting held by Kikai group, visiting Macadamia Fans' factory and attending the local Sunday market in Kibugu. The observations relating to the number of macadamia trees and banana stems in the area, harvesting, husking and drying of macadamia nuts, transportation, and storage provided us with important information on the local banana and macadamia production at the first stages of the value chain.

## Humidity and Temperature Measurements

Humidity and temperature was measured inside and outside a storage room in Ngerwe, Kibugu during the dry season for 74 hours with Maxim Integrated iButtons® and compiled through the program 1-Wire Driver. Previous research on macadamia storage has shown that humidity and temperature changes are correlated with quality changes in macadamia kernel post-harvest, proving to be a vital indicator of on-farm macadamia nut storage feasibility (Walton & Wallace, 2010; Walton et al., 2013). One iButton was used to record temperature and humidity inside a storeroom within a concrete house in the research site, the other was placed in a tree outside on the farm. This experimental data could then be compared to show the potential effectiveness of local storage in comparison to literature concerning on-farm storage of macadamia.

# Results Analysis

## Kibugu farmer typology

This typology is compiled from the entire set of questionnaire and SSI data. Although there is an unavoidable discrepancy in sample size between the two data sets, the findings from the SSIs are expounded to the larger questionnaire population. The typological Kibugu farmer in the research site is 60 years old, married, attained a primary school education, has 5 people living in the household, and cultivates a 2.25 acre plot. The farmer grows bananas (97% of respondents) and macadamia (71%), but ranks the nuts from his 23 macadamia trees to be a crop more vital to his income (35%) than his bananas (13%) (Appendix 8). Coffee remains his primary source of income (63%). Although he sells the bananas (74%) provided by his 35 banana stems, he views it more as a food source and does not engage in value-addition activities. Bananas produce continuously with supply peaking after the rainy seasons in August and December, at which time he receives 100 KES per bunch, a significant drop from the usual negotiated price of 200-300 KES (Appendix 7). Any unsellable or overripe bananas are consumed or used

as animal feed contributing to low PHL. Macadamia nut buyers' different quality criteria results in the farmer selling his entire macadamia nut harvest from the March-May and October-December production mostly to middlemen. The farmer still experiences some post-harvest loss (69%), most often with maize (31%). From the above activities as well as dairy production and sales from other crops, the typical Kibugu farm receives an income of below 10,000 KES per month.

## Maize post-harvest loss mitigation loss strategies

PHL in maize is not a trend limited to Kibugu, and is the focus of much of the post-harvest research conducted in East Africa. Among the crops mentioned in the questionnaire, maize PHL averaged 30%, due mostly to pests and rodents and high moisture content during storage. Around 13% of respondents have adopted the hermetic sacks advocated by extension officers and the National Cereal Board. Nearly all respondents declared a drop to zero in post-harvest losses following adoption. One still noted about 10% in loss, while an outlier mentioned losses of 50%, most likely attributed to pre-storage PHH losses. While the bags cost 100 KES more than the traditional gunny sack, adoption was not correlated with income levels. Furthermore, the hermetic sacks displace the otherwise necessary and costly application of pesticides post-harvest. The only variable correlated with adoption was farm size: the average farm of questionnaire respondents was 2.25 acres, while adopters showed an average of 5.65 acres. Rationale for the correlation could stem from the need of larger farms to store more maize, forcing storage technologies more to the forefront. Simple cost-benefit analysis of adoption reveals benefits outweighing cost as substantiated by the income-detached adoption. Shallow product penetration is likely related to a paucity of information. Grains and their dearth of PHH stages allow for simple and effective intervention. Strategies for horticultural and cash crops with their multi-stage PHH and off-farm influencing factors are more complex in Kibugu and are explored below.

## Adoption of post-harvest handling strategies for banana and macadamia

Factors that cannot be manipulated by the farmer exist largely in the external world or result from characteristics of the crop in question. Farmers can control, in part, the interactions between the farm level and external world. Movements further inwards to the farm level and the individual level allows perceptions of expected costs and benefits of the activity to be more easily shaped by the farmer. An attempt to ascertain an individual farmer's weighing of the expected benefits and expected costs of the strategy is an uncertain errand. However, by analyzing concrete economic costs and benefits followed by a comparison with the main factors influencing farmer perception of the expected costs and benefits, a rationalization of the farmers' choices can be obtained (Figure 5). The section below will present in detail the cost/benefit analysis and influential factors for banana value-addition and macadamia handling.

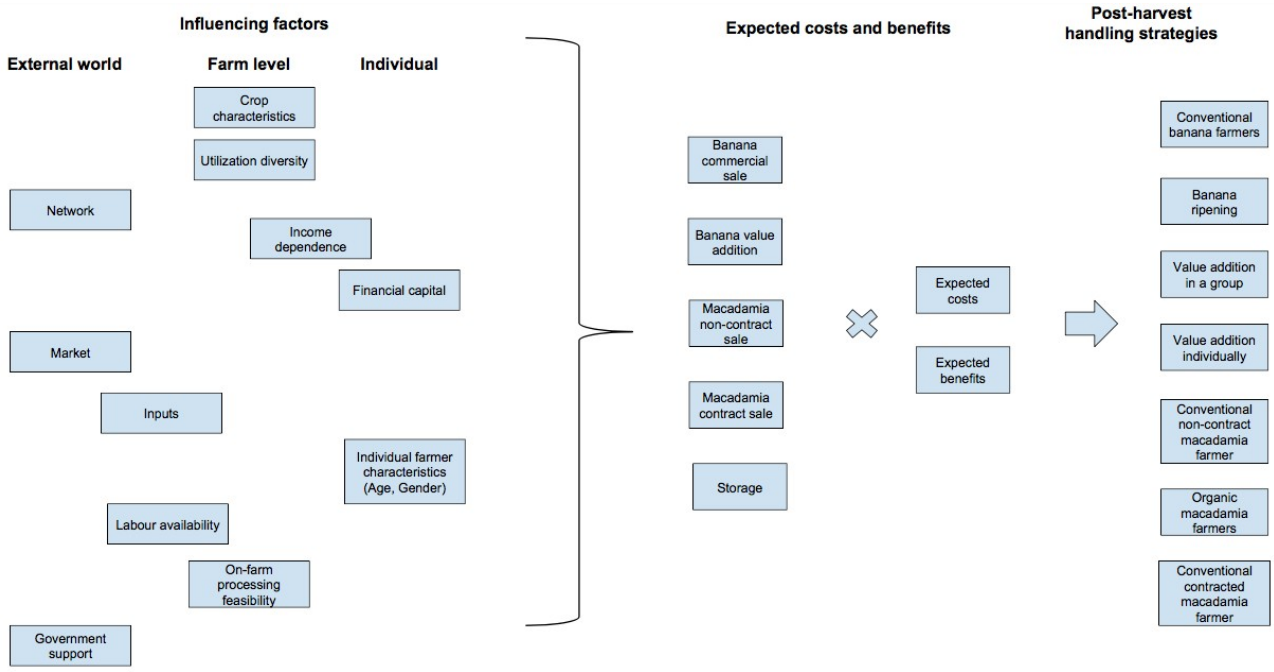



Figure 5: Factors influencing farmer perception of choice within rational choice framework

## Banana value-addition

### *Economic Valuation*

Three farmers doing banana value-addition were interviewed (Appendix 5). Each farmer adds value on different levels: 1) VA1 is 40 years old and ripens her bananas for commercial sale, 2) VA2 is 22 years old and processes bananas to crisps and flour by himself, and 3) VA3 is a young woman of 23 years and manager of a former women's group turned banana processing company, Kikai Foods, that processes banana into crisps, flour and cakes, and has a plan of expanding to higher production and adding banana wine to their products.

Comparing the prices of selling bananas raw versus processed shows a clear benefit of investing time into processing banana (Table 2). By processing bananas, a value between 500-1,200 KES/bunch is added according to the farmers interviewed. Interestingly, the ripening of bananas (VA1) has the highest added value, even though the method does not involve any major costs and time. However, the selling of the ripened bananas is limited to the months in which supply is low as there is no demand when the banana supply is high. Processing bananas into crisps, flour, cakes or even wine can be done throughout the year when equipment is available, which gives a higher additional income compared to VA1 (Table 3). However, such endeavor requires certain startup capital. As seen in Table 4, the startup costs vary substantially. VA2 had a start-up cost of 2,200 KES, spending his own saving as startup capital. VA3, on the other hand, startup capital shared with Kikai Foods totaled 267,250 KES, corresponding to 44,541

KES per member. Beside monthly contribution of 5,000 KES per member (at that time 20 members), Kikai Foods (including VA3) had the advantage of receiving 220,000 KES in seed funding and an influx of 120,000 KES a few years later. Furthermore, Kikai Foods will receive a grant of 5 million KES with which they will expand production with a new dryer, equipment to produce wine and widen their market with a KEBS (5,800 KES per product) and ISO (15,000 KES per product) certification.

Besides startup capital, monthly costs are also necessary for both VA2 and VA3 (Table 5). The main costs can be divided into three categories: 1) Packaging (bags and labels) 2) Additional banana supply from other farmers and 3) Labor for production and transportation. Both VA2 and VA3 have the equipment needed to pack their products but VA2 does not have his own label and buys them from VA3 and Kikai Foods when needed at events (additional income for VA3). When their own production of bananas is insufficient, VA2 and VA3 buy additional bananas from other farmers. The price varies between the rain and dry seasons. To the high demand of water by bananas trees: banana supply is lower during the dry season, therefore prices are higher and vice versa. As a member of Kikai Foods, VA3 does not require hired labor for the processing, whereas VA2 hires labor for processing to be able to meet demand. Both VA2 and VA3 pay 50 KES per km for transportation when needed.

Table 2: Price (KES) per bunch banana for each interview on banana non-value-addition and value-addition in Kibugu Location (Appendix 10).

| No of farmer | Non-value-addition (NV), KES/bunch | Value-addition (VA), KES/bunch |
|---|---|---|
| 1 | 200 | 1,200-1,400 |
| 2 | 250-300 | >800** |
| 3 | * | 1,283 |

*The number of bunches sold per month was not given by NV3 and can therefore not be added to this table.
**VA2's income mostly comes from banana flour production, which averages 800 KES per bunch. VA2 also gets some income from crisps, but he was not sure of this amount, since he only sells a very small amount to relatives and friends. The total amount is therefore a minimum of 800 KES per bundle.

Table 3: Monthly additional income, expenses and final income from banana processing for each of the interviewed doing banana value-addition.

| | VA1 (KES/month) | VA2 (KES/month) | VA3 (KES/month) |
|---|---|---|---|
| Additional income | 2,000 | 15,000 | 8,000 |
| Expenses | 0 | 10,000 | 3,000 |
| Final income | 2,000 | 5,000 | 5,000 |

Table 4: Startup costs (KES) of VA2 and VA3.

| Start-up costs | VA2 (KES) | VA3 (KES) |
|---|---|---|
| Miller | | 95,000 |
| Dry house | | 45,000 |
| Building for miller and sink | | 40,000 |
| Oven | | 30,000 |
| Water tank | | 5,000 |
| Installation of sink | | 2,000 |
| Bag sealer | 2,000 | 3,000 |
| Weight | | 45,000 |
| Slicer | 200 | 2,250 |
| **Total** | **2,200** | **267,250** |

Table 5: The major monthly costs (KES) mentioned by VA2 and VA3.

| Monthly costs | VA2 (KES) | VA3 (KES) |
|---|---|---|
| Labeling (per 50 labels) | 1,000 | 0 |
| Bags for packaging (12 bags) | 500 | unknown |
| Bananas from other farmers (dry) | 400 | 300 |
| Bananas from other farmers (rain) | 150 | 200 |
| Labor for processing (per bunch) | 200 | 0 |
| Labor for transportation (per km) | 50 | 50 |

*Factors influencing farmer's perception of costs and benefits*

Despite the benefit of a substantial increase in income and the fact that all non-value-addition farmers interviewed have heard about banana value-addition and expressed interest in it, 96% of farmers questioned are not doing so. Various factors influencing farmer's perception of the cost and benefits of choice were mentioned by the farmers and officers interviewed on banana value-addition.

Farm level

Due to its *crop characteristics*, bananas benefit the farmer by continuous production with two main harvest seasons per year following the two rainy seasons (Appendix 7). Additionally, the only *inputs* necessary for production are manure during the initial planting and wooden supports to prevent the banana bunches from falling before harvest, yielding low production costs. However, the small average size of farms and the fact that banana trees require a lot of water (1200-2200 mm per year) limit the production of bananas. Regardless of the size of harvest, ripening bananas is always a *feasible on-farm processing method*. If sufficient supply and equipment are available, bananas' options for *diverse*

*utilization* include crisps, flour (baby food, bread, etc.), cakes and wine. Depending on the aim of the production process, this can be done in small or large scale. However, when operating at small scale, the drying of bananas for crisps and flour is limited to the days with dry weather: VA3 can produce 12 kg of flour in 2 days when the humidity is low, but when the humidity is high, production of the same amount requires 5 days.

Individual

*Age* and *gender* were the two main *individual farmer characteristics* shaping choice. In addition, an older farmer (50+) might not have the ability to find information online, constraining knowledge sharing to farmers' local network like NV1. VA2 became aware of the idea of doing banana value-addition from television and further researched the topic on the internet. Additionally, many farms are owned by older farmers and the young family members therefore need permission from their family to start such a business, as in the case of VA2. Support can be a challenge as older farmers are more averse when it comes the risks of taking a loan. The SSIs show younger people being more open to taking risks and value-addition strategies. The number of commitments increases with age leading to more reluctance to take risks (Kahan, 2008). VA3 noted that age can also affect the availability of grants, since some funds see a higher potential in supporting a young farmer and are earmarked as such. Gender affects the choice of men, including NV2 due to the assumption that NGO and government supported trainings on value-addition are targeted at women only. According to the post-harvest officer, some farmers additionally think it is necessary to be a woman to join a value-addition group.

As mentioned, *financial capital* for equipment and certifications is needed to add more value than that afforded by ripening the bananas. Equipment and certification are expensive, which is a major limitation for farmers. Farmer risk aversion is often related to financial ability; smallholder farmers that are market-oriented are generally more risk-averse, a stance related to consideration of farm input costs and output benefits (Kahan, 2008). VA1 that ripens bananas is aware of the other possibilities of adding value, but thinks it is too expensive and risky to borrow money. NV2 argued that the government should provide the startup capital as taking loans can be risky. According to VA3, getting grants for their start-up of Kikai Foods was one of the two main challenges to founding the company. However, for farmers questioned bananas are only a minor part of their income. Therefore, *income independence* on banana production is low, which decreases the risk of investing time into value-addition. For example, the income of VA2 does not rely on banana value-addition, even though it can surpass his income from the other crops from the farm and delivering newspapers.

External world

The resources farmers have to grow their business depends on the extent and diversity of their *network*, e.g. contacts with buyers, funds, other farmers etc.. Extensive networks facilitate knowledge transfer: aided by the network compounding effect of the internet, VA2 and VA3 were able to reach others knowledgeable about value-addition practices and funding. Diverse networks, in the form of multiple buyers for VA2, creates stable revenue sources. Regardless of whether the farmer is a member of a group or independent, creating a network is time consuming; VA3 attends on average 30 events annually to expand their network, whereas VA2 lack of networking has limited his sales to local markets and friends and relatives. VA2 has encountered difficulty networking with some events requiring entrance fee or preference being given to larger companies that can meet higher demands. The Venn diagrams (Appendix 9) show the clear difference between the extent and diversity of VA2 and VA3s' networks. VA3 also benefits from Kikai Foods' group nature that creates a foundationally larger network, each group member brings his or her own network to bear, but also the agents involved in production, marketing and distribution of their products.

The size of the network is also reflected in the value-addition farmers' perception of the *market* for banana and its products. VA1 and VA2, having a smaller and more local network, show low demand for their products, decreasing in some periods. VA3 with a relatively developed network (including a contract with the company Azuri Health LTD), experiences high demand, ensured by a contract with Azuri Health LTD to deliver the amount of flour that is possible for them to produce. According to the post-harvest officer, some farmers believe it is easier or even necessary to be in a group to access the market for value-added crops. Being in a group increases the *labour availability*, upon which production is dependent. On average, VA3 and the other members of Kikai Foods spend three days a week on production. When time is available, the members transport bananas from other farmers themselves, otherwise costs of 100-150 KES per delivery are necessary. Both VA1 and VA2 are supported by their families, which lower the costs of labor. For farmers with small families or little labor support from relatives labor availability can be a limit to increase production. Being in a group can, however, also bring challenges. VA3 noted being in a group as the second main challenge of founding the company. The company, Kikai Foods, started out as a women's group, Kigaro Star, with 50 members, but squabbling over whether to distribute or reinvest the funds in the business, reduced their membership to 20 after the first grant, which was further reduced to 6 members after the second grant.

In general, the non-value-addition farmers believe that the government facilitate adoption of value-addition, noting primarily increased access to financial capital and training as instrumental. Agricultural extension officers are available for value addition trainings on a weekly basis in Kibugu and are willing to

come to individual farms, but are time constrained. According to the post-harvest officer, few farmers seek these offers from the government. This is due to various reasons, including the already mentioned issues of age and gender. NV3 was not aware of the training offered, possibly attributed to a limited ability in accessing online information (NV3 is 72 years old). NV2 is aware of the free trainings offered, but regards the training as only available for women. Additionally, NV2 and NV3 think better roads are needed to see sufficient benefits from value-addition. NV2 thinks the government should bear some risk and provide funds for startup capital. However, VA3 received the training that sparked the idea for Kikai Foods from the NGO "Hand in Hand", which still provides free trainings approximately twice a month to Kigaro Star and its network.

For farmers not adding value to bananas the government has, according to the extension officers, founded marketing groups to collectively bargain for higher banana prices at local markets. Through the marketing group farmers can sell their bananas per kilo instead of per bunch, earning 11-24 KES/kg. However, the farmers must adhere to certain rules and regulations for producing bananas, e.g. produce certain commercial varieties, pay a membership fee, and produce a minimum amount. These requirements limit farmer's ability to join the group due to costs and work entailed in modifying their banana productions. Farmer NV2 cited the disrupting group dynamics as a reason why he would not join one. One banana market seller also said she left the group because of corruption. From the questionnaire and interviews, it appears that only few farmers are part of the marketing groups, while the majority selling to middlemen. Therefore, engaging in simple banana value-addition, such as ripening banana or producing a small amount of banana crisps, seems to be more beneficial than selling the unripe banana production.

## Macadamia post-harvest handling strategies

In this section, the cost and benefits of adopting two post-harvest strategies for macadamia, contract farming (Appendix 5) and on-farm storage, are described, comprising 1) an economic valuation of the proposed activities and 2) how the factors influencing the farmer's perception of expected costs and benefits manifest themselves within the strategies.

### *Economic Valuation*

In contrast to value-addition activities in bananas, adoption of the investigated PHH strategies in macadamia nuts is directly coordinated with market/buyers. All farmers stated price as the determining factor in their choice of buyer, the income generated from the sale being seen as the primary benefit. Therefore, adoption of strategy is heavily governed by price. In determining this non-negotiable price, farmers have the choice of immediate sale to middlemen or companies (farmers MN1-3), contracted sale to companies (farmers MC1-3), or ostensibly to store the nuts to wait for the prices to rise (no farmers).

Middlemen approach farmers during the harvest season and offer a price (Table 6) as well as transport for the nuts from the farm, appropriating 5-10 KES per kg, depending on the variety and buyer, in the process. Payment is immediate and in cash, however prices are volatile and directly correlated to the market. Sale to companies is similar to the middleman relationship. Companies offer a price, which the farmer can accept or reject, however the farmer often must transport his own nuts to the company, incurring costs.

Contract farming varies with the 10 company buyers present in Kibugu, but only two companies in the area, Jungle Nuts (JN) and Macadamia Fans (MF), contract to facilitate organic production. JN contracts 215 farmers in Kibugu, while MF has 5000 throughout the surrounding area. The potential for higher prices and closer relationship between buyer and seller in organic contracting focuses the investigation into contract farming with JN and MF. Organic contracting carries additional benefits and costs reflected in the price. Contracts, organic or otherwise, are not obligatory, and farmers are more than willing to sell to the best offer. However, guarantees of a price floor (80 KES) for MF farmers, the purchasing of the entire JN farmer's harvest regardless of quality, and an extra 15 KES added to JN's end of season bonus insulates farmers from price volatility and offers higher prices for higher quality (Table 6).

Storage of the nuts is a strategy advocated by the two extension officers interviewed and is being implemented in the form of farmer trainings. According to the officers, farmers use 100 KES sisal gunny sacks, each containing 90 kg of the nuts in shell (NIS) for storing after husking. These sacks must then be hung, allowing for air movement through the covered storage area. As supply dips with distance from the March harvest season, the price of macadamia nuts rises (Table 6). The stored nuts that have experienced "minimal weight loss," according to the post-harvest officer, can then be offloaded and sold for much higher prices.

Table 6: Illustrates the prices received, costs, and income benefit for different strategy adopter's macadamia nuts.

| Strategy | Implementer | Price (KES) | Direct costs* (KES) | Income potential** (KES) |
|---|---|---|---|---|
| Contract w. FarmNuts, BlameNuts | MC1 | 60** | 0 | 79,350 |
| Contract w. MF | MC2 | 100 | 0 | 132,250 |
| Contract w. "Chinaman" | MC3 | 100 | 0 | 132,250 |
| Contract w. JN | None | 115, 130 (organic) | 0 | 153,238, 173,225 |
| Middlemen | MN1, MN2, MN3 | 80, 80, 100 | 0 | 106,600, 132,250 |
| Storage of 1-2 months | None | 120-130*** | 1500 | 159,900-173,225 |
| Storage of 3 months | None | 200 | 1500 | 266,500 |

* Calculated using typical farmer's 23 trees yielding 57.5 kg
** MC1 currently sells to middlemen for 80-90 KES
*** Prices obtained after storing is year dependent, prices after 1-2 months have reached highs of 140-150 KES

*Factors influencing farmer's perception of costs and benefits*

From a price received valuation, contracting with JN and storage would appear to have high adoption rates, however no farmers interviewed had adopted the strategies. Factors beyond the immediate monetizable costs and benefits influence the weight farmers attribute to a cost or benefit.

Farm level

At a foundational level, macadamia trees display certain *crop characteristics* from which many other factors stem. Macadamia trees require little effort and inputs to cultivate. All farmers painted the trees as easily managed in comparison to the fickler coffee trees. The effort that is required, often in the form of some hired outside *labor*, is during the semi-annual harvest seasons, the periods of March-May and October-December. The vast majority of the production occurs during the March-May harvest. Outside of these times, macadamia trees only require *inputs* in the form of fertilizer or manure application during tree planting. Pesticides were avoided by many farmers to avoid dependence on mitigating insect damage to the flowers and nuts.

The nut is a cash crop that is consumed little in the region, leaving sale as the only livelihood strategy, exhibiting a low farm-level *utilization diversity*. However, the high oil levels of the nut and its perception as a high-quality product, have led uses as an oil, high-quality animal feed, and raw consumption. While having many uses, the nut must be dried from 22-27% moisture content to 1.5-3% before it can be further processed. According to JN and MF, natural drying can reduce moisture content to around 10%, therefore drying is conducted in factories at industrial scale, leaving little room for *on-farm processing*.

Individual

Nuts of all qualities are purchased with animal feed and oil being produced from the immature and insect damaged nuts. The ability to offload an entire harvest coupled with a general rise in demand has driven up prices from 40 to 100 KES over the last five years, increasing the share of income generated from the crop. Farmers rely largely on this one harvest and buying period to produce the share of their income derived from macadamia nuts, which provides their first large influx of cash in the year until the coffee harvest in November. This has created *income dependence* on macadamia nuts amongst farmers in Kibugu. Next to coffee and if present, dairy production, it constitutes the largest singular source of income for many of the farmers. Among the farmers surveyed via the questionnaire that delineated the different sources of agricultural income, 84% mentioned macadamia as one of the top four most important crops to their livelihoods. Dependence does range, however, from 2% for MC1 up to 75% of the income generated by the husband in the MN3 household.

External world

Farmer dependence on a single production season, the low utilization diversity and on-farm processing feasibility of the crop have exposed farmers to risk at the hands of the buyers. Surging demand has rewarded this close relationship with higher farm gate prices. Middlemen are the least insulated from the market, offering prices directly correlated to the market and provide the benefit of immediate payment and transport. The typical farmer is not contracted and chosen to benefit from the rise in prices offered by the middlemen over the costs of dealing with contracts. Companies who pay out at a later date, wait until the nuts have shed water weight to weigh (referenced by MC1), or do not pay at all (MN1) have pushed farmers towards middlemen.

Both contract farming and storage are methods of governing the farmer's inelastic relationship with pure market demand in the form of middlemen. The *government* has even attempted to protect farmers from the market by introducing a maximum price of 140 KES per kg and actively recommending storage through post-harvest officers. Contract farming seeks to supplant farmer's relationship with the market with one of their own. To facilitate adoption of contract farming, MF has attempted to shift perception of farmer's risk to backstage payment handling by introducing a fingerprint system that pays the nuts weighed in front of the farmer immediately to his mobile banking (M-Pesa) account, effectively rendering the process more akin to that of the middlemen. By replacing market demand, the companies can introduce strategies like MF's price floor, several companies collectively calling themselves the NutPack have cooperated on a 70 KES price floor, to further insulate farmers from the market. Storage detaches the farmer from the immediacy of the market, providing flexibility in the choice of when to sell. Unlike contract farming, storage does not replace the relationship between the farmer and the market, but rather

places the costs of the strategy through the loss of weight in the nuts or losses due to fungus or pests squarely upon the shoulders of the farmer. These risk sharing mechanisms have led to higher rates of adoption, JN reported that 10% of their contracted farmers had registered in the span of two and half months.

Organic contracting further deepens the relationship between company and farmer. Farmers are provided with free certification and monitoring, trainings, and access to organic *inputs*, sharing the risk of adopting the strategy. The organic fertilizer, at 2000 KES per 50 kg bag, is also cheaper than the 2500 KES synthetic. Even with the benefit of price stability and in the case of JN, a higher price, adoption comes with significant cost: according to the EU certification system used, "The entire agricultural holding shall be managed in compliance with the requirements applicable to organic production" (European Union Council, 2007). Farmer MC2 corroborates this requirement: as a farmer contracted with Macadamia Fans all of his holdings are organically cultivated. Even with macadamia trees' low input requirement, MC2's tree produced an average of 50 kg per tree compared to his neighbors' average of 88 kg per tree. While the drop in production may be related to other factors, the inability to use conventional *inputs* pesticides and fertilizer could significantly affect production of other crops including pest susceptible coffee and tomato. The two crops currently do not have a *market* for organic accessible in Kibugu, therefore organic coffee and tomatoes with depressed production would be sold for uninflated conventional prices. *Income dependence* plays a large role in determining costs and benefits; a farmer like MC2 that derives 25% of his income from macadamia is more likely to adopt such a strategy than MC1, who only sees 2% of his income from macadamia.

Storage feasibility is liable to both temperature and humidity. Fluctuations in either can make macadamia nuts more susceptible to losses from pests and fungus during storage. Figure 6, 7, 8 and 9 is a comparison of temperature and humidity data collected over the course of 74 hours from outside in the farm and inside a storage area in a concrete house:

Figure 6: Outside temperature in Ngerwe, Kibugu during the dry season

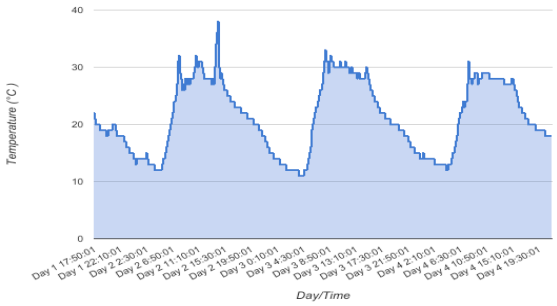



Figure 7: Inside temperature in Ngerwe, Kibugu during the dry season

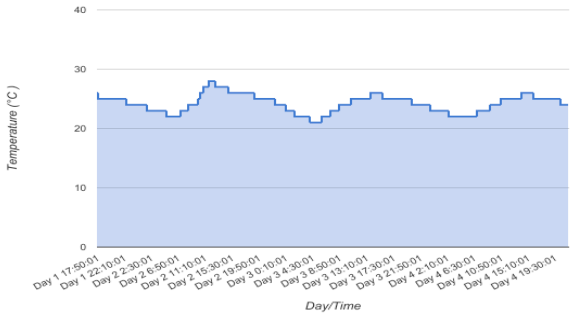



Figure 8: Outside humidity in Ngerwe, Kibugu during the dry season

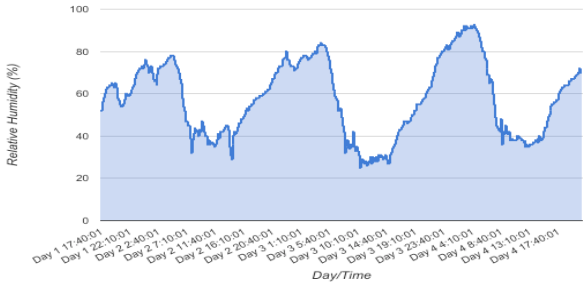
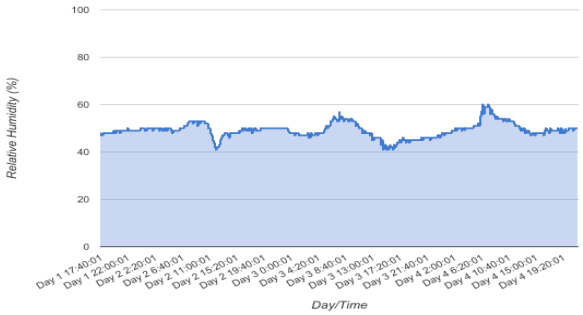



Figure 9: Inside humidity in Ngerwe, Kibugu during the dry season




Outdoors, the humidity fluctuates between 25% and 95% relative humidity (RH), peaking before dawn, while temperature peaks during daylight hours and fluctuates between 11°C and 38°C (Figures 6 and 7). Inside the storage area, temperature is relatively more stable, falling between 21°C and 28°C, with an average of 24.2°C (Figure 9). The inside humidity hovers around 50% RH. As with temperature, humidity fluctuations inside track with the outside, but experience about a four-hour delay due to the insulating qualities of concrete (Figure 8). The significant drop in the amplitude of temperature and humidity fluctuations between the storage area and the outside supports the post-harvest officers claim of the necessity of a storage shed. Furthermore, the officers dispute the buyers' statements that nuts can only be stored for up to three weeks through the natural drying process. The value-addition officer regards three months as possible, after which farmers could receive near 200 KES per kg. Farmers cited fear of weight loss in the nut due to drying in during storage, thereby decreasing the amount received for the same amount sold immediately post-harvest as the reason for not adopting storage. This is direct contrast to the officers saying that little weight loss would occur.

Table 7: How moisture content reduction and the different prices collude to improve prices farmers receive for their nuts.

| Moisture Content (%) | Price (KES) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 70 | 90 | 110 | 130 | 150 | 170 | 190 | 200 |
| 25 | 93,275 | 119,925 | 146,575 | 173,225 | 199,875 | 226,525 | 253,175 | 266,500 |
| 20 | 88,611 | 113,929 | 139,246 | 164,564 | 189,881 | 215,199 | 240,516 | 253,175 |
| 15 | 83,948 | 107,933 | 131,918 | 155,903 | 179,888 | 203,873 | 227,858 | 239,850 |
| 10 | 79,284 | 101,936 | 124,589 | 147,241 | 169,894 | 192,546 | 215,199 | 226,525 |
| 5 | 74,620 | 95,940 | 117,260 | 138,580 | 159,900 | 181,220 | 202,540 | 213,200 |
| 1.5 | 71,355 | 91,743 | 112,130 | 132,517 | 152,904 | 173,292 | 193,679 | 203,873 |

The then current harvest season yielded prices of an average of 100 KES per kg with an after-season bonus of 15 KES per kg (Table 7). Under these ideal conditions, our farmer generates 153,238 KES per year. Even if the nuts drop to 10% moisture content, the farmer with generate more income if the price rises above 128 KES per kg.

Even with potential for significant boosts to income earned from macadamia sales, little to no startup costs, and *government support*, farmers still do not adopt the strategy. Farmers with lower *income dependence* on macadamia and more diverse sources of *financial capital* may be more willing to engage in storage strategies because of the lower risk adoption would pose to their livelihoods. Regardless, the lack of risk sharing mechanism in the event of the failure of the strategy does not provide a gateway to adoption.

In contrast to the value-addition strategies for banana, *individual factors* like age and gender play little role in adoption. Even in detaching themselves slightly from the larger market for macadamia, farmers are not utilizing their *network* to find options for *financial capital* or for a market. The demand for macadamia nuts creates an atmosphere in which the market approaches farmers. A diverse network does, however, facilitate the flow of information, from which farmers can learn of opportunities for alternative PHH strategies for macadamia.

# Discussion

## Shortcomings of the rational choice framework

In order to make a rational choice, fully weighing the expected costs and benefits of a certain activity, actors must have complete information regarding these costs and benefits (Green, 2002). It is unlikely that any farmer in Kibugu has access to perfect information regarding potential activities. For example,

multiple farmers cite a lack of knowledge about value addition trainings as inhibiting their decision to engage in the activity. Not only do these farmers have a slightly cloudy picture that will further affect their ability to choose rationally, but the information that is most accessible may not be perfect, or even false. The agricultural extension officers interviewed mentioned several times that in their attempts to train farmers to store macadamia, middlemen and companies were duping farmers into thinking it would be harmful to the quality, weight, and income generation potential to store nuts for longer than a couple of days. Given farmer's low capacity to properly store the nuts for three months as referenced earlier, information gaps also lead to misinformation further clouding the reality necessitated by assuming perfect information.

While all SSIs conducted showed that receipt of the best price is the determining factor in making the choice of which buyers to sell to, such rationality is more muddled in the choice to engage in value-addition activities. The potential for low start-up costs and an additional source of income would likely induce such a choice, however farmer characteristics, base risk aversion being paramount, exact a toll on agent rationality.

## Reflection of results

### The case of Banana

The results from our research reflects the wealth of literature pointing to value-addition as a method to increase farmer income. For example, a study looking at the cost and benefit of adopting low-cost methods to process fresh horticultural products into local snacks, found these methods to be profitable, cost effective and of appropriate scale to be adopted by small-scale producers in Africa and South Asia (Saran et al, 2012). Despite the economic benefits this research and literature indicate, the typical farmer is not adopting value-addition methods. As stated by Fehr, small-scale farmers try to avoid unnecessary risk to their livelihood (Fehr, 2010). This was clearly seen in the farmers who chose not to do value-addition, as they saw the risks associated to shifting to value-addition to be higher than the perceived benefits. Like contract farming in macadamia, forming groups is a mechanism farmers use to spread risks and increase benefits, an idea that was constantly present in farmer's testimonies (Birachi et al, 2013). Groups also make it easier for farmers to reach the scale of production necessary to benefit from available markets, as in the case of Kikai Foods (Ibid). Farmers considered groups an almost necessary component in enabling them to do value-addition. However, negative experiences with cooperatives and issues with group dynamics also factored into farmer's decision-making and reflect factors also pinpointed by various authors as troublesome with groups (Fehr, 2010). Lack of technical skills and poor access to knowledge

are often cited as common constraints smallholder farmers face for refining their production processes, and not surprisingly, these came up as two of the major barriers farmers saw to starting value-addition (Birachi et al, 2013).

Bananas have multiple avenues for processing, as noted by Adeniji et al., and can be easily done on-farm (2010). A number of the methods the value-addition farmers in Kibugu have applied themselves mirror those mentioned in the literature. However, as Adeniji also writes, for these activities to generate more income and jobs, improvements must be made in the technologies used (2010). This was clearly seen in the farmers interviewed who saw investment in new technology as key to increasing the production and consequently their income.

Consumer preferences are also important in dictating to farmers how a product should be (Fehr, 2010). While the consumers' influence is not straightforward in the research, it is clear that for farmers doing value-addition, reaching a bigger market requires adherence to a certain set of general consumer quality standards (Pradhan & Pradhan, 2015). Moreover, for the product to penetrate bigger markets, processing methods, packaging and marketing has to reflect this goal (Birachi et al., 2013). Farmers doing banana value-addition remarked on the impact these components had on their ability to reach bigger markets. Additionally, with better links to these sought-after markets, farmers could significantly increase the return on their products (Birachi et al., 2013). Although not reflected in the results, the existence of bigger and newer markets is key to sustaining the growth of banana value-addition products (Ibid). In general, more investment and extension activities are needed for the growth and development of the value chain (Roy, 2015).

## The case of macadamia

In the case of macadamia, the story was slightly different. The choices of post-harvest handling available to farmers was more limited given the difficulty of on-farm processing. Therefore, farmer's choice of strategies was largely limited to engaging in contract farming and storage. Farmer's decision to rely on contracts for a guarantee on prices can be interpreted as strategy to safeguard his "welfare level" against price risk (Barrett et al., 2012). The main reasons cited by farmers, guaranteed or stable and high prices, are the same reasons for contracting production as found in other studies on the topic (Miyata, 2009). Several studies have shown that contract farmers can experience increases in their income (Ibid). However, this was not necessarily the case with the farmers in Kibugu. Furthermore, in comparison to contract farming described elsewhere, Kibugu farmers were not beholden by their contract to sell to the company. Side-selling was common occurrence among contracted farmers in Kibugu, detracting from the significance of the contract itself. In order to increase rates of contract farming adoption, farmers require

up-to-date market information as well as higher integration to high-value markets, such as the market for organic macadamias (Roy, 2016). As reflected in the results, farmers will need to consider the crop yield gap between organic and conventional agricultural production (De Ponti et al., 2012).

The surge in macadamia prices is correlated to its rise as a share of income amongst Kibugu farmers and has heavily influenced farmers' adoption habits of new PHH strategies. In the face of price fluctuations, the typical farmer's inelastic relationship with the market and their heavy reliance on the income derived from macadamia could lead to adoption of strategies insulating them from a suddenly bad market. Between 2010-2014 the production of macadamia more than doubled in Kenya, reaching a production of 5,448 metric tons of shelled nuts in 2014 (MoA, 2015; INC, 2015). The nut's high global demand is among one of the reasons why macadamia is a focal crop for Kenyan smallholders. The main factor in the current increase in prices of macadamia is the ongoing drought in South Africa (Mintec, 2016). If the drought in South Africa ends, according to Australian Phil Zadro, one of the world's largest producers of macadamia, South Africa would have the potential to double their current production of 13,146 metric tons (Buchanan, 2017; INC, 2015). If South Africa were capable of producing such an amount, the 30% increase in supply could potentially result in a worldwide drop in price affecting farmers in Kibugu selling macadamias, repeating the story of coffee production. In 2009, the price of coffee experienced a major price fall in the wake of the 2008 financial crisis (ICO, 2009). Macadamia also experienced a brief 60% drop in the crop value from 2007 to 2009 before returning to current levels (MoA, 2010). If the price were to drop again, contracted farmers would be insulated from price volatility through a price floor, whereas the middlemen would buy at what would likely be a lower price.

## Macadamia storage

The agricultural extension officers noted the ease of adopting storage techniques, the following explores the feasibility of such a strategy given the collected temperature and humidity data with reference to outside literature. When macadamias are harvested the NIS typically has a moisture content of 22-30% (wet basis, w.b.). The first post-harvest operation is the removal (husking) of the outer shell, which should be practiced within 24 hours after harvest as the heat from respiration builds up inside the nut (AMS [1]; Walton et al., 2013). Macadamia nuts should be harvested, husked, sorted and delivered to the factory in shortest possible time period to minimize quality loss (AMS [3]). If necessary, it is not recommended to store NIS on-farm for more than two weeks, unless the NIS moisture content can be reduced below 10% within the two weeks (AMS [1]). Controlling the RH of the air to between 60% - 70% RH will dry the nuts to about 10% moisture without over drying. In this period, it is also important that the maximum temperature never exceed 30°C (AMS [3]). Once dried to 10% moisture, NIS are only able to be stored for about two weeks at 25°C before the shelf life of the product is affected (AMS [2]). Processors do not

recommend drying below 10% on-farm to avoid kernel damages incurred during transport (Kowitz et al, 1996). To further dry the nut, permitting longer storage, depends on temperature, RH, and airflow. To control RH and temperature at a favorable level requires adequate airflow, which can be affected through fan-assisted aeration. The RH around the NIS affects the drying and the lower RH the faster the NIS dries (Walton et al., 2013; AMS [2]). Furthermore, the NIS should be stored in silos or bins designed for drying (AMS [2]).

Therefore, one of the biggest constraints for farmers' possibility to store NIS on-farm is the capital expense of installing new drying systems, which is beyond the reach for many farmers (AMS [3]). Additionally, without access to such climate control systems, neither the outside nor the inside storage climate in Kibugu, as shown in Figures 6-9 of the results, is suitable to dry and store macadamia on farm. Efforts to dry below 10% moisture content will be affected by the RH fluctuating between night and day. With an average inside storage temperature of 24.2°C, NIS of moisture content of 15% and 12.5% stored in such conditions, fungus has been shown to develop after a half month and one month, respectively (Kowitz et al, 1996). Below 5°C, regardless of moisture content, fungus development is retarded, lengthening shelf life. Cooling to such a temperature would require a massive capital investment.

## Methodology Limitations and Results Discrepancies

The results obtained reflect the choice of methods used and a combination of factors that affected the data collection process. The data collected mainly came from farmers living in Ngerwe village. Of the 12 farmers interviewed, 3 were from outside Ngerwe. From analyzing the complete questionnaire set, which encompasses farmers from all around Kibugu, some discrepancies between the Ngerwe farmers and the rest of Kibugu farmers were identified. Only 70% of all farms in Kibugu cultivated macadamia, versus 100% in Ngerwe, which could have skewed the importance attributed to macadamia. The other discrepancy is the larger size of farms in the Ngerwe, 3.9 acres versus the average of 2.25 acres in the whole of Kibugu, which may explain why planting of macadamia trees, a recently very profitable crop, is more widespread in Ngerwe. However, the income levels in Ngerwe are consistent with the rest of Kibugu. Ngerwe is further away from Kibugu, the area of initial settlement, therefore there were less people in that area initially, leading to larger plots, but people are generally less well-off per square meter, i.e. level of wealth is the same even though the farms are bigger.

The use of questionnaires was important in getting an overview of the area, but were time consuming and some questions, realized during the questionnaire interviews, came out as confusing or poorly worded. This limited the potential of the questionnaire. A more thorough review of the questions was warranted. Semi-structured interviews served as the main source of information for the research. The choice of key

informants was based on questionnaire results as well as accessibility. In the case of farmers doing banana value-addition, it was limited to who could be interviewed, which could have resulted from the systematic random selection of farmers for the questionnaire in the area, or was a reflection of the lack of farmers doing value-addition in the area. There were also key informants that could have been interviewed to get a more complete picture, such as farmers forming part of marketing groups, the value- addition extension officer of the area and macadamia farmers growing organic macadamia. As previously noted, the use of translators was necessary to obtain more detailed answers from the farmers. Even when the farmer could speak English or Swahili, the farmer felt more comfortable and could give a more detailed answer when talking in Kiembu. One of the disadvantages faced by using an interpreter is that some of information might have gotten lost in translation.

Discrepancies in the results stemmed both from the choice of methods and the nature of the data. Some of the data could not be verified because lack of methods to triangulate. For instance, when farmers were asked whether there were food losses, quite a few said that no post-harvest losses occurred. Moreover, a couple of the farmers who did, only did so when prompted multiple times and gave at times a "random" answer. When asked to give a numerical amount for food losses, many were not able to answer or appeared to give any answer to please the interviewer. It was not possible in the truncated research period to measure the post-harvest losses through other methods to compare against the farmers' answers. Other questions relating to numerical amounts also suffered from the same issue. The issue is a common problem in research on post-harvest which mostly derives its data from guessing rather than from actual measurements (Hodges & Bennett, 2011).

However, some of the discrepancies resulted from the distinctive points of view of the different stakeholders, which colored the answers they gave. Through the interviews it became clear that farmers perceive food loss in a different way. For farmers, even if they cannot sell their crop, they will repurpose it, consume it or give it to the livestock, creating the notion that no food is lost. However, when talking to the extension officer they cited high percentage of food losses and considered part of food losses any crop grown for commercial sale which could not be sold, even if it served another purpose inside the farm. Another difference that came through was farmers' and macadamia companies' different perception of contract. The "contract", or more specifically, the agreement between farmers and the company was regarded more strictly by the company, while farmers considered it more informally.

## Reflection on group work

Before the fieldwork in Kenya, the group met on skype to introduce each other and discuss the theme and connected field methods. This was further discussed on all the group members' arrival to Nairobi, Kenya.

The group was formed of several nationalities, cultures and disciplines, which the group managed to use and take advantage of. Students with other nationalities (Colombia, USA and Denmark) than Kenyan contributed with an outside point of view, while the Kenyan students prepared the non-locals and explained the endemic culture. This helped to better understand the action and choices of farmers and other locals that was observed and interviewed. The various disciplines (Masters of Agriculture Development, Geography, Anthropology, Environmental Governance and Climate Change) broadened the knowledge available. By combining the various perspectives from the disciplines and the different cultures, the group's understanding of the complexity of post-harvest processing and value-addition was improved. While the group exploited the knowledge of each specialist, each participant amassed new knowledge and learned new field methods from each other. As a group in general, each member contributed equally throughout the process of preparation, fieldwork and writing. To gain as much information and data as possible, the tasks of both collecting data in field as well as preparation was efficiently distributed among the group members. On a daily basis during the fieldwork and every second day during the preparation and writing, all group members met to share the knowledge obtained to ensure the project's process.

## Conclusion

Farmer choice of post-harvest handling strategies in Kibugu Location result from an analysis of expected costs and benefits analysis conducted in a frame constructed of factors exerting influence from the external world, farm level, and the internal world of the farmer's individual characteristics. The dearth of information on value-addition techniques and associated costs served to avert adoption for farmers considering value addition. The age of farmers also played a role, with young adopters having more access to information from their relative grasp and access to the internet. In the case of macadamia post-harvest handling, storage detaches the farmer from the immediacy of the market, providing flexibility in the choice of when to sell. On the other hand, contract farming insulates farmers from the market, protecting farmers from price fluctuations. For both crops, risk also played a significant role in the adoption of new strategies, manifesting itself rationally in actor's feeling of the expected costs of the activity, but also, possibly, irrationally in base risk aversion. Certain conditions facilitating the adoption of new strategies helped to allay this risk. Risk sharing mechanisms present in both the banana value-addition in the form of groups and the contract farming in macadamia have proven to be beneficial for farmers and have led to adoption of new post-harvest handling strategies. Lack of adoption of storage techniques for macadamia can be explained by requiring the farmer to assume the full risk of detaching himself from the market to wait for higher prices. Furthermore, the information on the topic presented by government officials contradicting the literature further debases storage as a viable option.

## Recommendations

In the negotiations between buyer and seller of macadamia nuts, the farmer has no control of the price and can only reject the offer. These negotiations are conducted on an individual basis and expose farmers to the risk of manipulation by the buyer. Although collective action in Kibugu has run into problems of corruption, as in the case of the coffee cooperative, and infighting, collective bargaining can help farmers to share the risk they face at the hands of the buyers and negotiate prices with companies for macadamia nuts. This collective action would then be able to extend risk sharing mechanisms into the buyer and seller relationship further normalizing mechanisms like a price floor, purchasing guarantees, and immediate receipt of money as already implemented with Macadamia Fans, Jungle Nuts, and the middlemen, respectively. This transparency of information must also extend beyond the buyer-seller to the relationships between extension officers and farmer. The high costs and risks of storage must be communicated and the trainings on the techniques clarified.

Extension officers could play a significant role in helping to mediate conflict within groups that have undertaken collective action like bargaining or value-addition and make information on the techniques of value-addition, especially for bananas, more available to those without access or a grasp of the internet. Within this information, a clear picture of the potential costs and benefits must be articulated so that farmers can make a rational choice.

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Content

Appendix 1: Final Synopsis

# Challenges and constraints mitigating post-harvest losses in Kibugu, Kenya

Final Synopsis

University of Copenhagen

Interdisciplinary Land Use and Natural Resource Management

SLUSE 2017


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Contents

## Introduction

Post-harvest loss is a major challenge in Africa negatively affecting food security for millions of smallholder farms; more than 70% of the population in sub-Saharan Africa (SSA) depends on agriculture for income and consumption (Abass et al., 2013). Post-harvest losses are mainly incurred during post-harvest handling. In Kenya, a lack of adequate post-harvest handling has led to average estimated post-harvest losses of 20%-30% (Odongo, 2013). With the growing global population, especially pronounced in SSA, food consumption, and the requisite demand, will increase. Within SSA, Kenya is experiencing particularly acute population growth, averaging an additional 1 million people per year (World Bank, 2016). Amelioration of post-harvest losses and intensification of farming systems are needed to meet the inevitable increase in national consumption as well as the surging export market. Together, the two have situated agriculture as a main contributor of Kenya's GDP, reaching 30% in 2014 (World Bank, 2014).

Kimiywe (2015: 490) defines post-harvest loss as: "*measurable qualitative and quantitative food loss along the supply chain, starting at the time of harvest until its consumption or other end uses*." FAO categorizes loss from the handling into five stages: 1) harvesting, 2) post-harvest handling, 3) processing, 4) distribution and marketing, and 5) consumption. At which stage the greatest post-harvest losses occur varies between crops. For instance, in SSA, with respect to grains, the highest losses occur during harvest and post-harvest handling on farms (Kaminski and Christiaensen, 2014), but horticultural crops experience the highest losses during processing, packaging and distribution (Kimiywe, 2015).

Overall, post-harvest loss is positively correlated with humidity and temperature across post-harvest processes along the value chain from farmer to consumer (Kaminski and Christiaensen, 2014). Moisture and temperature during storage are the determining factors in the creation of microclimates conducive to mould growth as well as the proliferation of pests and diseases. Grains, having lower moisture contents than other crop types, are easier to store without technologies. However, unfavourable weather conditions, such as increasing average temperature or higher rainfall, can require external technologies to preserve crops (Kimiywe, 2015).

Post-harvest handling affects the crop quality and thereby both the possibility of selling the crops and its value, determinants of the revenue of the farmers receive for their crop (Kimiywe, 2015). Developed countries play a key role when it comes to crop quality and export in developing countries such as Kenya. In general, export of crops from developing countries is believed to favour economic growth, especially as agriculture often composes a large portion of national GDP in low-income countries. Studies have shown a five-fold increase in average annual income in households that export vegetables (Asfaw et al., 2007). However, developed countries, such as those in the EU, require farmers to be certified under

certain standards of food safety and quality. To fulfill these requirements, various technologies can be necessary, exacerbating the divide between wealthier, export-focused farmers and their non-export counterparts (Rao and Qaim, 2013). In addition, due to poverty and lack of sufficient processing, packaging and good infrastructure, farmers often have to sell crops quickly after harvesting to avoid post-harvest losses. During the harvest season farmgate prices are low due to oversupply, reducing farmers' revenue and forcing them to buy grain after the harvest season to meet their family's consumption demand (Kaminski and Christiaensen, 2014).

Several studies show that post-harvest losses decrease with improved transport infrastructure, storage practices, processing facilities and more accessible information and effective communication (Kimiywe, 2015; Abass et al., 2013; Odongo, 2013). Farmers utilize various methods to reduce post-harvest losses (see appendix 1). However, apart from poverty preventing farmers to decrease the post-harvest losses with investment in improved processing and storage technologies, such improving factors are often either not available or insufficient in low-income countries (Ehui and Pender, 2003). Additionally, the diversity of smallholder-cultivated crops is high and also highly variable within Kenya, requiring a complex portfolio of handling technologies and techniques leading to higher losses.

Amidst this diversity, losses incurred post-harvest will vary from crop to crop. Factors including the storability and durability as well as susceptibility to post-harvest diseases and pests will influence the degree of these losses (Kimiywe, 2015; Kaminski and Christiaensen, 2014). Mycotoxins, and especially aflatoxin, is detrimental to maize production, however the storability, or base shelf life of maize and grains in general, is understandably superior to most horticultural products. Horticultural products like fruits and vegetables suffer high losses due short shelf life and their susceptibility to fungi and pests post-harvest (Kimiywe, 2015). Aside from issues of storage, processing can also lead to significant losses. Highly processed products like coffee and macadamia nuts, both cultivated in the field site, will have demonstrably longer shelf lives after processing than horticultural products. This very processing, especially when automated and adhering to quality standards demanded of cash crops often bound for foreign export markets, leads to inflated processing losses (Asfaw et al., 2007).

Grain, horticulture, and cash crop products can be said to exist on a constructed spectrum. Conceivably, in Embu County, grains exist on the left of the processing spectrum: processing and storage is conducted in situ, ergo the majority of food loss occurs internally from issues of immediate post harvest handling (5-8%) and storage (3-5%) (NRI, 2014). Manual processing reduces potential for processing losses. Horticultural products with a medium market, often bound for Nairobi or foreign markets as well as some auto-consumption, will face greater quality selectivity, an external pressure incurring losses in processing

(Colbert & Stuart, 2015). Larger issues with storage, no longer exclusively in situ, and the introduction of a transportation element, raises the potential for loss at this stage. Horticultural products with their mix of in and ex situ processing and storage fall in the middle of the spectrum. On the right, cash crops like coffee and macadamia nuts are processed off-farm in collectively owned, or otherwise, plants. The foreign export market almost exclusively determines demand for these crops, leading to possibly volatile prices and demand, i.e. coffee, only 3% of that which is produced is consumed domestically (Gitonga, 2015). While storability is less of an issue, in this case cash crops like macadamia nuts and coffee, which feature a more pronounced shelf life than horticultural products, the focus market and the ex situ processing sees higher losses occurring further off-farm and down the value chain.

This constructed spectrum is neither faultless nor intransigent, however the implications of this cursory delineation warrant a categorical analysis. Intra-category investigation does not preclude inter-category comparison, but rather fabricates a comparative framework to analyze suppositions of post-harvest loss. Ideally, cross-categorical crops like avocados, both a horticultural product and cash crop, would be explored to test the validity of this spectral analysis. Given the high percentages of losses attributed to the different post-harvest value chain stages and the reverberations felt up and down the value chain therein, the research to be conducted in Kibugu location in Kenya will be largely aimed at examining how challenges of mitigating these food losses are manifest within the scope of the farming household unit in the aforementioned categories. The resulting research question: *What are the challenges and constraints to adopting methods to mitigate post-harvest losses in a grain, horticultural, and cash crop in Kibugu, Kenya?*

Several sub-questions further demarcate bounds of the investigation: 1) *At what stages and how do post-harvest losses occur?* 2) *How do losses further along the value chain affect farmers?* 3) *What is farmers' perception of post-harvest losses?* 4) *How do farmers act upon the constraints to mitigate post-harvest losses?* and 5) *Why are people not using methods available for mitigating post-harvest food losses?*

Case studies towards this topic are crucial for smallhold farmers and essential since post-harvest losses are subject to major issues towards development of individual livelihoods. The knowledge drawn upon this research will give a more in depth perspective of the exact stages where post-harvest losses occur and why different individuals act differently towards post-harvest losses.

## Methodology

In order to collect the necessary data to answer the research question, a variety of qualitative and quantitative methods will be used. The group will conduct informal observations of Kibugu location and

farms to identify key places and key informants to more thoroughly analyze. Informal conversations with locals will also be carried out at the primary stages of the data collection period to establish important ideas and themes to delve into. The methods described below will help establish archetypal farmers of each crop type, facilitating the subsequent analysis.

## Proposed Methods

### *Questionnaires*

The quantitative data gained from questionnaires will be used to decide which particular crops to focus on and will give an overview of the extent of the issue of post-harvest losses. We hope to do the questionnaires in the beginning of the fieldwork to see new patterns that we could further explore in semi-structured interviews, PRA sessions and focus groups. The questionnaire will help identify potential informants. Since questionnaires do not allow us to go into detail, the semi structured interviews will allow us to explore and build upon new interesting themes if they occur while gathering quantitative data. Quantitative data gives numbers and answers that can easily be compared and related to each other. The questionnaire would give an overview of which crops are grown, changes in crops grown, storage practices, if/at what stage in the process losses occur and which crops are sold at markets etc. The informants are farmers in Kibugu, the adults in each household. The questionnaire will be a common questionnaire shared among the different groups. Each group will add five questions and the questionnaire will include five more general questions in the introduction. This will give a lot of data to work with and increase the credibility and ability to see patterns in the survey. The final sampling strategy has not yet been decided by the different groups, but the different areas of Kibugu that the groups live in will all be included and therefore a big area will be covered. The questions will mostly be yes-no questions and will be worded simply to avoid misunderstandings.

### *Participatory Rural Appraisal*

Participatory rural appraisal (PRA) methods will be employed to get a better understanding of the post-harvest process in Kibugu through the perspective of the farmers.

*1) Venn/Chapati Diagram*

A myriad of actors (e.g. farmers, buyers, government officials) are involved in the post-harvest process. By asking farmers to draw a Venn/Chapati diagram of their extend of relationship and the importance they give to these different actors, connections or disconnections present in the system will be clearer. The key players identified through this exercise will also serve as potential avenues to focus on.

*2) Ranking Exercises*

Through this exercise we will be able to pinpoint from the farmer's perspective: the most important crops in terms of value, biggest factors of post-harvest loss, main areas for potential investment in post-harvest processing, crops giving the most financial benefit. This exercise will be particularly important to help identify the main crops that the study will center on.

*3) Seasonal Calendar*

Farmers will be asked to construct a seasonal calendar with all the activities done in the farm. The aim of the calendar is to get an overview of the different crops grown, and the activities associated with them. Whether post-harvest activities and the manner in which these are represented by the farmers might indicate the level of work and resources the farmer has to devote to them. It will also help in discerning how the labour is distributed along the year among the different farming tasks, pinpointing the periods throughout the year where there are peaks of labour and resources might be scarce.

*4) Transect Walks*

Transect walks will be used to get a better grasp of all the steps/actions involved in the post-harvest process. Through the walk some of the features that could be distinguished include: farm methods, practices and technologies used for harvesting, distances between factors of cultivation, storage and processing spaces. A GPS device and a measuring tape will be used to measure the distance between the different units of the farm and to calculate areas, such as the size of fields and storage and/or processing areas of the crops. With the information from the transect walk, visual observation and conversations with the farmer a post-harvest flow map can be constructed to visualize the interaction of the different components.

## *Analyzing Storage Units*

Crop storage is a key component of the post-harvest process. When immediate consumption or selling of a crop is not possible or appropriate, properly storing the crop is important for keeping the crop in a state fit for consumption or use at a later date (Bala, 2016). After identifying and describing the type storage crop facilities present on the farm, the temperature and moisture content within the crop will be measured through the use of an iButton sensors of temperature and humidity . This will be done for a series of days to determine variability. For both grains and horticultural products temperature and moisture content are tied to the level of metabolic activity, which is connected to level of deterioration of the crop (Bala, 2016) (Thompson, 2015). Under this premise, the measurements on the temperature and moisture level will tell whether the climatic conditions inside the storage facilities are appropriate for the crop in question by making reference to the literature on ideal storage conditions.

*Mapping of spatial distribution of the supply chain*

Through the use of GPS imaginary, observations and feedback from the different stakeholders identified with the Chapati/Venn Diagram exercise, a map of the spatial distribution for the different crops chosen will be constructed. This map will allow to analyze in a scale of space and time the different stages of the post harvest process within the context of Kibugu.

*Semi-Structured Interviews*

The semi structured interviews allows us to go in dept h and ask more detailed questions. The informants will be the farmers, local buyers, local officials and vendors in the market. Interviewing these different groups will clarify when and to what extent post-harvest losses occur and therefore not just at the farm level. The purpose of the interviews will be to understand the post-harvest handling practices of the farmers and their reasons for using or not using different strategies to avoid losses. Before the fieldwork, an interview guide will be made. However, the questions will be open-ended and the interview is flexible and can take a new direction if an interesting theme occurs (Casley & Cumar 1988). We will start out with assuring people that they are anonymous. However, we have had considerations about translator and the fact that translator may know informants. Before beginning the interviews we will discuss our project and aims with our translators to avoid misunderstandings during interviews. If possible, a second interview will be arranged, to follow up and ask further into details as new interesting viewpoints may show up once we start.

*Focus Groups*

The focus groups will be carried out in the end of fieldwork, after questionnaire and semi structured interviews. The knowledge we gain from the above two methods will therefore be used to establish a focus group discussion with the farmers. The ideal amount of people would be five and the participants will be encouraged to discuss open questions. If possible we will arrange two focus groups, one for men and one for women, to see if there are different opinions or perceptions between genders.

We have considered the fact that having to translate everything said in the focus group would take away the flow of the discussion. Therefore, we will provide the participants with some questions to discuss, then we will leave the room in order for them to discuss freely. Afterwards we will ask them to sum up the five most important conclusions or points of their discussion. Our translator will observe the discussion and take notes. The meeting will be recorded and the interpreter will go over it with us afterwards.

## Collaboration with counterparts

At the time of writing, we have been in close contact with our Kenyan counterparts. We have exchanged ideas on the project and hope to work more closely with the Kenyan team to establish parallel data collection objectives and methodology.

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# Appendix 1 (Synopsis)

| Method | Effect | Description | Reference |
|---|---|---|---|
| Pre-harvest | | | |
| Fertiliser | Nutrient balance during crop growth →lower loss of storage life and quality | Fertilise soil | Thompson (2014: Ch. 6) |
| Insecticides | Diseases →extend storage life | Spray crops on field | Songa et al. (2002) |
| In situ | | Delay harvest | Thompson (2014: Ch. 7) |
| Post-harvest treatments | | | |
| Cold chain | Stabilize crop | The temperature of the crop is reduced rapidly after harvest | Thompson (2014: Ch. 6) |
| Change of temperature | Pests and diseases | Exposing the crop to brief periods of high or low temperature after harvest | Thompson (2014: Ch. 6) |
| Chemicals | Various effects: Diseases, pests, extend storage life, maintain quality | Injection, dip or spray of the crops after harvest | Thompson (2014: Ch. 6) |
| Hot water treatment | Control diseases (e.g. fungi), extend storage life | Immersed in or brushed with hot water before storage or marketing | Thompson (2014: Ch. 6) |
| Vapour heat treatment | Control infections of fruit flies in fruit | Boxes of fruit are stacked in a storage room that is heated and humidified with steam | Thompson (2014: Ch. 6) |
| Post-harvest storage | | | |
| Metal silos | Reducing insects in maize | Storage containers in rooms | Gitonga et al. (2012) |
| Raised wooden structures / on top of trees | | Storage within homestead | Songa et al. (2002) |
| Burying / pits / trench | Protect crops and provide a humid environment | The crops are buried below-ground | Thompson (2014: Ch. 7) |
| Super grain bags | Reducing insects in maize | Storage containers in rooms | De Groote et al. (2013) |
| Temperature and humidity control of storage room | Reduce respiration, metabolism, extend storage life | Stabilise surrounding environment | Thompson (2014: Ch. 7) |

## Appendix 2 (Synopsis)

Timeline:

| Month | March | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Arrival in Langata | | | | | | | | | | | | | |
| Initial meetings w. Kenyan counterparts | | | | | | | | | | | | | |
| Standardizing interview process w. counterparts | | | | | | | | | | | | | |
| Moving in w. host family | | | | | | | | | | | | | |
| Informal conversations w. local farmers/Observations | | | | | | | | | | | | | |
| Questionnaire distribution | | | | | | | | | | | | | |
| PRA: Venn/Chapati diagram | | | | | | | | | | | | | |
| PRA: Ranking exercise | | | | | | | | | | | | | |
| PRA: Transect Walks | | | | | | | | | | | | | |
| Measurements of storage climate | | | | | | | | | | | | | |
| Measurements of stored product moisture | | | | | | | | | | | | | |
| Semi-structured interviews | | | | | | | | | | | | | |
| Focus groups | | | | | | | | | | | | | |
| Community feedback | | | | | | | | | | | | | |
| Buffer day | | | | | | | | | | | | | |
| Return to Langata | | | | | | | | | | | | | |

# Appendix 3 (Synopsis)

## Data matrix

| Overall Objective | Research question | Sub-questions | Data Required | Activities | Inputs |
|---|---|---|---|---|---|
| To increase knowledge about how farmers mitigate post-harvest loss, and how they act upon challenges and constraints within the post-harvest process | 1. What are the challenges and constraints to adopting methods to mitigate post-harvest losses in a grain, horticultural, and cash crop in Kibugu, Kenya? | 1.1. At what stages and how do post-harvest losses occur? | Get a rough idea of how the crop is processed and stored, and identify disruptions in this process that can result in food losses | 1.1.1. Observation | Villagers/farmers, all available students, interpreters, questionnaire guide, pens, notebooks and operational facilities |
| | | | Get farmers' input of where these losses occur | 1.1.2. Semi-structured interviews with farmers | Villagers/farmers, 3 full-time students, 1 interpreter, 1 local guide, paper cards and markers, pens, notebooks, hardcopy method guides and operational facilities |
| | | | Accessible post harvest processing stage stakeholders located in Embu's knowledge about how and why losses occur | 1.1.3. Semi-structured interviews with stakeholders | Processing stakeholders, 3 full-time students, 1 interpreter, 1 local guide, paper cards and markers, pens, notebooks, hardcopy method guides and operational facilities |
| | | 1.2. How do losses further along the value chain affect farmers? | How farmer's feel food losses along the value chain and how it affects their choices and actions | 1.2.1. Semi-structured interviews with farmers | Villagers/farmers, 3 full-time students, 1 interpreter, 1 local guide, paper cards and markers, pens, notebooks, hardcopy method guides and operational facilities |
| | | 1.3. What is farmers' perception of post-harvest losses? | Sum up main areas of concerns among farmers regarding food loss, such as difference of importance of food loss for the crops grown, main areas for improvement in post-harvest processing, obstacles to reducing food loss | 1.3.1 Ranking exercise | Villagers/farmers, 3 full-time students, 1 interpreter, paper cards with crops, markers, pens, notebooks, hardcopy method guides and operational facilities |
| | | 1.4. How do farmers act upon the constraints to mitigate post-harvest losses? | Background information on the farmers: demographics, income, crops grown, changes in crops grown, storage practices, if/at what stage in the process losses occur and which crops are sold at markets etc. | 1.4.1. Questionnaire | Villagers/farmers, all available students, interpreters, questionnaire guide, pens, notebooks and operational facilities |

| | | | | | |
|---|---|---|---|---|---|
| | | | Identify components in the farm which are part of the post-harvest process (build post-harvest process flow map) | 1.4.2. Transect walks | All available students, 1 interpreter, 1 local guide, pens, notebooks and operational facilities |
| | | | Obtain the climatic conditions (temperature and moisture content) of storing units | 1.4.3. Analysis of storage units | Storage conditions, temperature gauge, moisture meter, 2-3 students, pens, notebooks, operational facilities |
| | | | Pinpoint actions by farmers in response to the food losses (processes, techniques, etc) | 1.4.4. Semi-structures interviews | Villagers/farmers, 3 full-time students, 1 interpreter, 1 local guide, interview guide, pens notebooks and operational facilities |
| | | | | 1.4.5. Focus groups | Groups of villagers/farmers (approximately 5 persons), 1-2 interpreters, local guide, interview guide pens, notebooks and operational facilities |
| | | | Identify actors part of the post-harvest process and their interaction with the farmer's methods of processing | 1.4.6 Venn Diagram | Villagers/farmers, 3 full-time students, 1 interpreter, 1 local guide, interview guide, pens notebooks and operational facilities |
| | | 1.5. Why are people not using methods available for mitigating post-harvest food losses? | Farmer's preference for one method over the other | 1.5.1. Ranking exercise | Villagers/farmers, all available students, interpreters, questionnaire guide, pens, notebooks and operational facilities |
| | | | Reasons for why they process a crop a certain way | 1.5.2. .Semi-structure interview | Villagers/farmers, 3 full-time students, 1 interpreter, paper cards with crops, markers, pens, notebooks, hardcopy method guides and operational facilities |

# Appendix 4 (Synopsis)

## Interview Guide, Farmers

**Introductory questions**

How many are living on the farm?
For how long have you owned the farm?/Does the land belong to you?
Do all family members help/work on the farm?

**Storage practices**

What are the storage techniques you use?
Do you know of other techniques that may benefit you? If yes, what are the reasons you don't use these?
How do you gain knowledge of storage techniques?
Has there been projects in your area offering new techniques? If yes, did you gain from this? And have you implemented them? Financial benefits?

**Crops**

How many different crops are you growing?
Have you changed the crops you grow?
Which crops do you sell?
Do you sell them on the market or to a factory?
Which crops are for home consumption?
How big a percentage of the crops you grow are for self consumption?
Who is responsible for what crops?
Which crop is most important? - Why?
Do the crops have to be of a certain quality for you to want to sell them at the market?

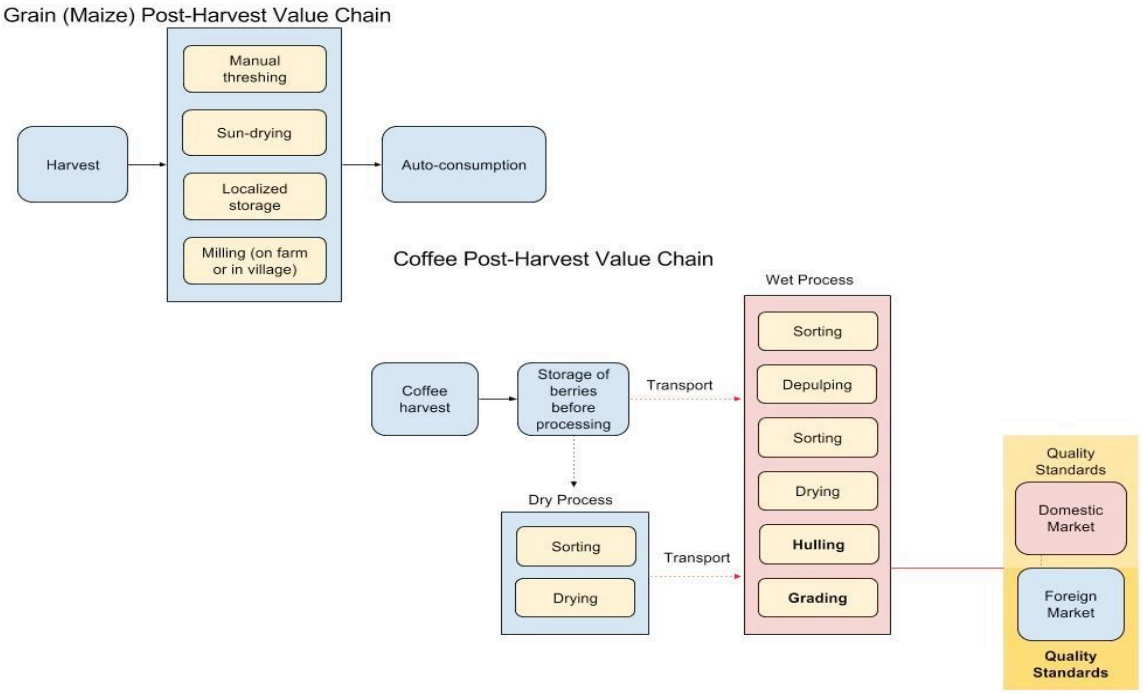
**Losses**

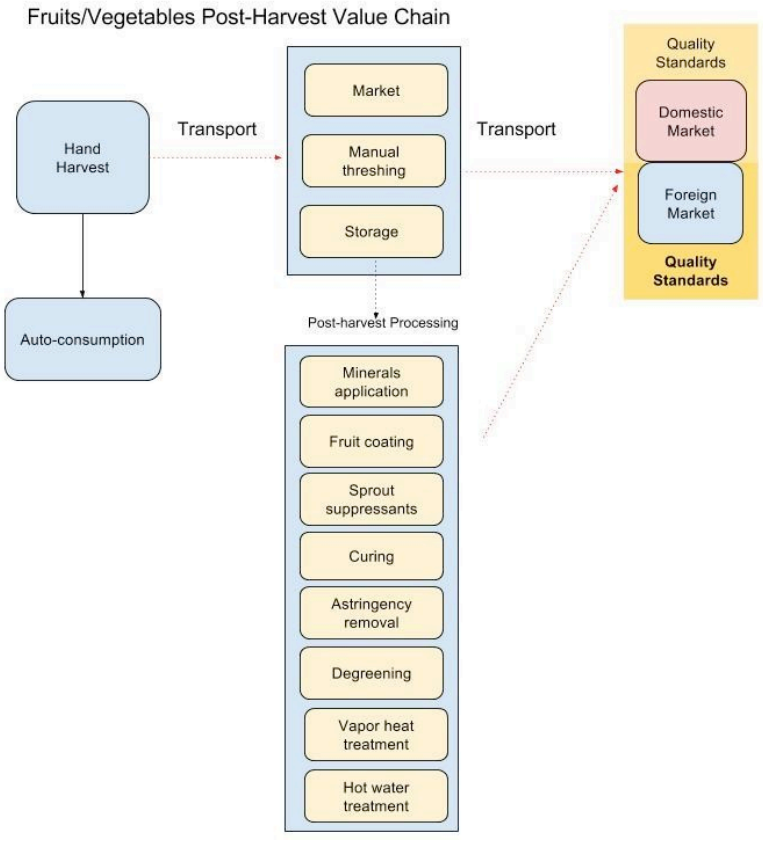
Are food losses an issue for you? Do
an issue for you? - How big an issue?
How big a percentage of the whole harvest is lost while on your farm? - How big a percentage of the different crops?
What, according to you, causes the losses?
What do you do to minimize the losses?
When in the process do losses occur?

**Investment?**

Do you trust banks, authorities, NGO's regarding investment?
Have you taken out any loans in relation to the farm? If not for the farm, for what have you used the loans for?
Have you used any of the loans for post-harvest processes? If so, for which ones? If not, for what in the farm have you used the loan for?
If you have never taken out a loan, have you considered it?
If yes, what has stopped you from it?

# Appendix 5 (Synopsis)



Appendix 2:

**Overview of applied methods**

| **Method** | **Number of respondents/test** |
|---|---|
| Questionnaire | 20 farmers |
| Informal interview | 2 banana market sellers<br>2 macadamia middlemen<br>1 miller<br>Various individuals at the market and Embu Agricultural Show<br>Our host families |
| Semi-structured interview | 12 farmers<br>2 government officials<br>1 macadamia buyer |
| Participatory rural appraisal | 2 chapati diagrams<br>2 seasonal calendars<br>2 ranking exercises |
| Participant observation | Not applicable |
| Humidity and temperature measurements | 3 days |
| GPS mapping | Not applicable |

# Appendix 3:

Work distribution (All group members contributed with editing all sections)

| | **Main authors** |
|---|---|
| **Abstract** | Catalina |
| **Acknowledgement** | Lærke |
| **Introduction** | Catalina & Henriette |
| **Problem Statement and Research Question** | Will |
| **Rationale Behind the Analysis** | Will |
| **Description of Field Site** | Lærke & Will |
| **Methods** | |
| **Questionnaire** | Henriette |
| **Informal Interviews** | Catalina |
| **Semi-Structured Interviews** | Catalina |
| **Participatory Rural Appraisal** | Lærke |
| **Participatory Observations** | Andreas |
| **Humidity and temperature testing** | Andreas |
| **Results** | |
| **Kibugu farmer typology** | Will |
| **Maize post-harvest loss mitigation loss strategies** | Will |
| **Adoption of post-harvest handling strategies for banana and macadamia** | Will & Henriette |
| **Banana value-addition** | |
| **- Economic Valuation** | Henriette |
| **- Factors influencing farmer's perception of costs and benefits** | Henriette & Catalina |
| **Macadamia post-harvest handling strategies** | |
| **- Economic Valuation** | Lærke, Andreas & Will |
| **- Factors influencing farmer's perception of costs and benefits** | Lærke, Andreas & Will |
| **Discussion** | |
| **Shortcomings of the rational choice framework** | |
| **Reflection of results** | Catalina & Andreas |
| **- Macadamia storage** | Andreas & Henriette |
| **Methodology Limitations and Results Discrepancies** | Catalina |
| **Reflection on group work** | Henriette |
| **Conclusion** | Will, Catalina & Andreas |
| **Recommendations** | Will |

Appendix 4:

# General Questionnaire for Kibugu

| | |
|---|---|
| **GPS-point: x: y: z:** | **Interviewer:** |
| **Sub-location:** | **Group Number:** |
| **Note taker:** | **Translator:** |
| **Picture:** | **Date and time: / / : :** |

**Personal information**

1. Name: _____

2. What is your gender? Male_____Female_____

3. How old are you? _____

4. Marital status:
a) Single_____b) Married_____c) Widowed_____d)Divorced_____

5. Which levels of education did you finish?
None educational background
Primary school
Secondary School
Tertiary level
Bachelor degree
Master degree

Other: specify _____

6. Are you a part of any of the following networks? (place an "X" in all choices that apply)
- Church
- NGO
- Cooperative
- Political party (you don't have to specify which party)
- Social club
- Others _____

**Household information**

7. How many people are part of your household (including workers, children and relatives contributing)?

_____

8. Name the 3 main income sources for your household?

_____
_____
_____

9. What is your household's income pr. month?

- Below 10.000
- 10.000-25.000
- 25.000-50.000
- Above 50.000

**Farm characteristics**

10. How many acres are your farm?

_____

I don't know _____

11. How big is your farm compared to the rest of the village?

a) Small_____b) Medium_____c) Large_____

12. How did you obtain the land of your farm?

- Inheritance
- Purchasing
- Renting
- Other:_____

**Pests and disease Management**

13. Have you heard of the Plantwise Plant Clinics organized by Centre for Agricultural Bioscience International (CABI)?

Yes
No

If no

- Have you visited any other agro-vet?

Yes
No

14. Have you any experience with using the plant clinics?

Yes
No

If yes

- How many times have you visited the Plant Clinics?

_____

- How will you characterize your experience with the Plant clinics?

Not satisfied
Satisfied
Very Satisfied

15. What are your most important crops? Add the disease/pest if any are present (list most important first - please state crop followed by pest/disease)

1. _____ _____
2. _____ _____
3. _____ _____
4. _____ _____
5. _____ _____

16. What are the most important crops infected with pests and diseases? (list most important first - please state crop followed by the pest/disease)

1. _____
2. _____

**Gender**

17.

| Activity<br>Crops | Which crops do you produce in your household? | Of the crops you produce in your household, which do you sell? | Of the crops you produce in your household, which are consumed in your household? |
|---|---|---|---|
| Mango | | | |
| Banana | | | |
| Passion fruit | | | |
| Avocado | | | |
| Kale | | | |

| | | | |
|---|---|---|---|
| Tomato | | | |
| Carrot | | | |
| Butternut | | | |
| Watermelon | | | |
| Potato | | | |
| Coffee | | | |
| Tea | | | |
| Cotton | | | |
| Macadamia | | | |
| Other | | | |

**Livestock**

18. How many of the following animals do you have in your household?

| Livestock group | Number of heads | Types/Breeds |
|---|---|---|
| Cattle | | |
| Goats | | |
| Sheep | | |
| Poultry | | |
| Rabbits | | |
| Donkeys | | |
| Pigs | | |
| Others | | |

19. Which household member has the right or responsibility to which areas of livestock husbandry?
*(Place an "X" in the boxes that applies)*

| | **Daily care** | **Income from milk sales** | **Income from animal sale (meat or alive)** |
|---|---|---|---|

| Type of livestock | Husband | Wife | youth | Hired labour | Husband | Wife | Youth | Hired labour | Husband | Wife | Youth | Hired labour |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

20. What do you think is the main livestock change you did in the last 5 years?

_____

21. Are you **member in a breeding association** or **milk cooperative**?
If yes, please specify:

| | Goat breeding/husbandry | Cattle breeding/husbandry | Milk cooperative | other, please specify |
|---|---|---|---|---|
| Put X if yes | | | | |

**Post-Harvest Management**

22. What are the storage technologies that you use?

List here _____

23. Have you adopted new storage technologies in the last 3 years?

- Yes
- If yes, what are they? _____
- No

24. Over the last 5 years, how many new crops did you begin growing? What are they?

_____

25. After harvest, what is the main cause/factor of crop losses?

- Pests, rodents,
- Rainfall
- Temperature
- Other: _____

26. Per harvest season, how much of harvest crops do you lose on average? And for which crop?

_____

Crop:

_____

27. Who do you sell your crops to?
    - Retail, i.e. Supermarkets
    - Middleman
    - Direct sale to consumers, i.e. Local market
    - Wholesale markets
    - Auto-consumption

28. Do you process your crops on the farm to add value?

    Yes
    No

If yes, state here:

_____

## Appendix 5: Semi-structured interviews list

*Key Informants*

1. Post-harvest extension officer
2. Agribusiness extension officer
3. Field officer for Jungle Nuts

*Macadamia nuts farmers - non-contracted (MN)*

| | |
|---|---|
| 1. Farmer 1 | MN1 |
| 2. Farmer 2 | MN2 |
| 3. Farmer 3 | MN3 |

*Macadamia nuts farmers - contracted (MC)*

| | |
|---|---|
| 1. Farmer 4 | MC1 |
| 2. Farmer 5 | MC2 |
| 3. Farmer 6 | MC3 |

*Banana farmers - value addition (BV)*

| | |
|---|---|
| 1. Farmer 7 | BV1 |
| 2. Farmer 8 | BV2 |
| 3. Farmer 9 | BV3 |

*Banana farmer - non value addition (NV)*

| | |
|---|---|
| 1. Farmer 10 | NV1 |
| 2. Farmer 11 | NV2 |
| 3. Farmer 12 | NV3 |

# Appendix 6: Interview Guides

**Semi-structured interview guide for Banana non-value addition farmers**

General Information

1. Gender:
2. Education background
3. How many people live in your home?
4. How many are male and how many are female? Male:_____Female_____
5. How many members of your families are involved in_____banana production activities? *Male*_____*Female*_____
6. Could you estimate (estimate both asset in kind including animal and cash) value of your farm in money units_____
7. How many major and minor farming activity related changes have you made in the last 3-5 years?
8. Do you have any non-agriculture sources of income in your household?
9. Do you overproduce any crops?
10. How do you handle overproduction of the above crop?
11. What is your farms area?

Production and Marketing Related Questions

12. How long have you been producing and selling banana? (years)
13. What banana varieties do you produce?
14. What is the primary objective of producing bananas:
15. How important are bananas to your overall income? (percentage)
16. How much of your time (including all your families) do you spend on activities related to production and/or selling as compared to all your other activities? (percentage) explained through the cropping calendar
17. What is the main constraint to increasing production?
18. During the past 3-5 years what changes have you seen on average in the demand for bananas?
19. If the demand for bananas is getting increasing and the price is attractive, why you did not sell more?
20. To whom do you sell your bananas to? In case you sell to more than one customer or group of customers, give in a rank of $1^{st}$ to $6^{th}$. (cooperatives, processors, whole sellers, retail/supermarkets, individual customers, institutional customers i.e. hospitals, schools)
21. Do you sell to the same buyer each time?
22. If your answer is yes to question number 20, why?
23. If your answer is no to question number 20, why?
24. Are you or have you ever been contracted to produce bananas?
25. How do you decide to whom to sell your bananas? Give rank from 1 to 4 based on your priority of criteria of decision (best price, business relationship, ownership in the cooperatives, delivery convenience (i.e. buyers who pick up the product)
26. How do you know at what price you should sell your bananas?
27. How do you deliver your bananas to the buyer?
28. If you are transporting to the selling center or to the buyers' site; what is means of transport?
29. When you do receive payment for the bananas?
30. Do you ever collaborate with other farmers in your vicinity?
31. If your question is yes to question number 30, why? Give ranks to the following reasons if it fits: to get better price i.e. increase negotiation capacity, share on transport, share information of price and

other, social relationships forces to do so)

32. Do you keep record of your sales so that you know when you sold more or less?
33. How much did you earn from sales on average per harvest season the last three to five years?

Inputs related questions

12. How you get your inputs for your banana production?
13. How you evaluate the price of inputs during the last three to five years?
14. Do you ever store the bananas before selling them? If so, why or why not?
15. If you do, do you have a specific place to store them?
16. Do you encounter any issues with storage? (spoilage, etc)

Value addition

17. Do you do any value addition to any of your crops?
18. Have you considered adding value to any of your crops? If so, which ones? Bananas?
19. If you have considered adding value, what keeps you from doing it and why? (i.e.financial, labour, and/or time constraints)
20. If you have not considered value addition, why not? Why not for bananas?
21. If there reason is financial for the last question, have you considered asking for a loan?
22. Do you know any farmers that do value addition? If so, for what crops?

Technical Service/Support and Enabling Environment Related Questions

23. Have you ever received any training on value addition in the last five years? If so, how many times, for what crops, and who provided them?
24. How do you evaluate the support from governmental organization and/or NGO in terms of providing support for value addition
25. How you does the basic physical infrastructure (roads, electricity, water, etc) affect your banana production? For selling and obtaining inputs necessary

Co-operation / Relationships related questions

26. Do you receive any service/support from your association/cooperative?
27. If your answer to previous is yes, how do you evaluate the services provided by your society to you in terms of training, input supply, technical support, etc in your banana production activities?

Planning related Questions

28. What are your future plans for your banana production?
29. What will be the critical inputs you need in implementing your desired plan? Give in rank from 1st to last where first is the most critical to last be the least critical input required: money/finance, labor, land, logistics services (transport, storage, etc), technical support.

**Semi-structured interview guide for Banana value addition farmers**

General information

1. Gender:
2. Age:
3. Educational background:
4. How many people live in your home?
5. How many are male and how many are female? Male:_____Female:_____
6. What is your household's income?

Farming

7. How many acres is your farm?
8. How much do you harvest per season?

Storage

9. How do you store the bananas?
    - **a.** What methods/techniques do you use for storage?
10. For how long do you store the bananas?
11. How do you store your products?
12. For how long do you store your products?
13. Are there losses during storage and/or processing?
    - **a.** How much?
    - **b.** At what stage(s)?

Production

14. What products do you make/produce?
    - **a.** Why did you choose to process bananas?
15. Do you only process your own products? Or do you process crops from other farmers?
16. If buying:
    - **a.** How much do you buy? (Amount/kg and price)
    - **b.** What criterion do you have for the bananas?
    - **c.** How do you choose the farmers you're buying from?
    - **d.** Do the farmers bring the bananas to you or vice versa?
    - **e.** Do the farmers need a minimum harvest amount for being able to sell to you? If yes, how much?
17. How do you process and pack the bananas?
    - **a.** How many bananas do you process per day?
    - **b.** What equipment / machines are used for both processing and packaging?
        - **i.** Did you buy the equipment yourself or did someone provide it?
    - **c.** Is the equipment that you have sufficient to the amount of products you want to process/produce and pack?
        - **i.** Why? / Why not?
    - **d.** What are the costs of the processing and packaging?
18. Are you certified by AFA?
    - **a.** How did you get qualified?
    - **b.** Was it difficult?
    - **c.** What were the costs of the certification?
19. If not, how do you ensure the quality and safety of your products? (any internal standards?)
20. Who are your main buyers?
    - **a.** For the different products?
    - **b.** Do you export?
    - **c.** What is the best selling product(s)?
21. For what price do you sell your various products?

22. How does your average buyers hear about your products?
23. What can (according to you) increase profits?

Value Addition

24. How did you get into processing bananas?
25. How did you invest in this business?
    **a.** Where/who did you get financial support from?
    **b.** Who manage the business / finance of the group?
26. What were the challenges in the starting process?
27. Have you participated in any training?
    **a.** Who provided the training? (government, NGO)
    **b.** Were you satisfied with the training?
28. Have you done any marketing?
29. How much more do you earn since starting to process bananas?
30. Have there been women leaving the group?
    **a.** Why?
31. What are your future plans? (Improvements, expansion)
    **a.** For the women's group specifically?
32. If a farmer wants to go into banana processing and approached you, what would you recommend?

**Semi-structured interview guide for Macadamia contracted farmers**

General Information

1. Gender:
2. Education background
3. How many people live in your home?
4. How many are male and how many are female? Male:_____Female_____
5. How many members of your families are involved in_____( name of commodity) production activities?
Male_____Female_____
6. Monthly income?
7. How many major or minor farming activity related changes have you made in the last 3-5 years?
8. Do you overproduce any crops?
9. How do you handle overproduction of the above crop?
10. What is your farms area?
11. How many macadamia trees do you have?
12. Do you have any non-agriculture sources of income in your household?

Production and Marketing Related Questions:

13. How long have you been producing and selling macadamia nuts?
14. How important are macadamia nuts to your overall income? (Assessed through PRA)
15. How much of your time (including all your families) do you spend on activities related to production and/or selling as compared to all your other activities?

16. Who in the family handles the production of macadamia nuts?
17. What is the average production (per tree)?
18. How much of what is harvested in sold?
19. How do you handle unsold macadamia nuts?
20. Do you believe that the production per tree/year can be improved?
21. If the answer to the previous question is yes; how can this possible?
22. What is the most constrained that makes you not to increase production in the past (finance, knowledge, market, logistics, other reasons)?
23. During the past 3-5 years what changes have you seen on average in the demand for macadamia nuts?
24. What about changes in price over same time frame (be specific)?
25. If the demand for your macadamia nuts is increasing and the price is attractive, why you did not sell more (can't produce, can't transport, don't have time)?
26. To whom do you sell your macadamia nuts?
27. Do you sell to the same buyer each time?
28. If your answer is yes to question number 26, why (get benefit from the profit of the buyer, strong trust in the buyer, no other buyers, have a contract)?
29. If your answer is no to question number 26, why (selling on best offer each time, different buyers approach me each time)?
30. If you are contracted, why did you decide to enter into a contract with the buyer?
31. Do you feel like your income from macadamia nut sales is higher because of the contract?
32. What are the requirements for you as the producer under the contract?
33. What are the requirements for the buyer under the contract?
34. Do buyers uphold their end of the contract?
35. How do you decide to whom to sell your macadamia nuts (best price, business relationship, ownership in cooperatives, delivery convenience)?
36. How do you know at what price you should sell your macadamia nuts (ask friends, ask traders, check at market, cooperatives determine price, accept price of buyer)?
37. How much do you sell your macadamia nuts at per kg?
38. How do you deliver your macadamia nuts to the buyer?
39. If you are transporting to the selling center or to the buyers' site; what is means of transport?
40. When do you receive payment for your macadamia nuts?
41. How much did you earn from sales on average last three to five years?

Inputs related questions

42. How you get your inputs for your farm?
43. In case you obtained input through subsidized purchase or donation, please specify the source
44. How have prices for inputs changed during the last three to five years?
45. Do you have storage for macadamia nuts? If so, for how long?
46. If your answer to question 42 is no, why not (I don't know its benefit, I don't have money to invest in creating it, I don't need it since I sell my product immediately)?

**Semi-structured interview guide - Macadamia non-contract farmers**

General Information

1. Gender:
2. Education background
3. How many people live in your home?
4. How many are male and how many are female? Male:_____Female_____

5. How many members of your families are involved in_____( name of commodity) production activities? Male_____Female_____
6. Could you estimate (estimate both asset in kind including animal and cash) value of your farm in money units_____
7. How many major farming activity related changes have you made in the last 3-5 years?
8. How many minor farming activity related changes have you made in the last 3-5 years?
9. Do you overproduce any crops?
10. How do you handle overproduction of the above crop?
11. What is your farms area?

Production and Marketing Related Questions:

12. How long have you been producing and selling macadamia nuts?
13. Do you have any non-agriculture sources of income in your household?
14. How important is "the product" to your overall income? (Assessed through PRA)
15. How much of your time (including all your families) do you spend on activities related to production and/or selling as compared to all your other activities?
16. Who in the family handles the production of macadamia nuts?
17. What is the average production (per tree)?
18. How much of what is harvested in sold?
19. How do you handle unsold macadamia nuts?
20. Do you believe that the production per tree/year can be improved?
21. If the answer to the previous question is yes; how can this possible?
22. What is the most constrained that makes you not to increase production in the past (finance, knowledge, market, logistics, other reasons)?
23. During the past 3-5 years what changes have you seen on average in the demand for macadamia nuts?
24. What about changes in price over same time frame (be specific)?
25. If the demand for your macadamia nuts is increasing and the price is attractive, why you did not sell more (can't produce, can't transport, don't have time)?
26. To whom do you sell your macadamia nuts to?
27. Do you sell to the same buyer each time?
28. Have you ever been contracted to produce macadamias? If yes, when and for how long? If no, have you considered it?
29. If your answer is yes to question number 20, why (get benefit from the profit of the buyer, strong trust in the buyer, no other buyers)?
30. If your answer is no to question number 20, why (selling on best offer each time, different buyers approach me each time)?
31. How do you decide to whom to sell your "X" product (best price, business relationship, ownership in cooperatives, delivery convenience)?
32. How do you know at what price you should sell your "X" products (ask friends, ask traders, check at market, cooperatives determine price, accept price of buyer)?
33. How much do you sell your macadamia nuts at per kg?
34. How do you deliver your "X" product to the buyer?
35. If you are transporting to the selling center or to the buyers' site; what is means of transport?
36. When you do receive payment for your "X" product often?
37. How much did you earn from sales on average last three to five years

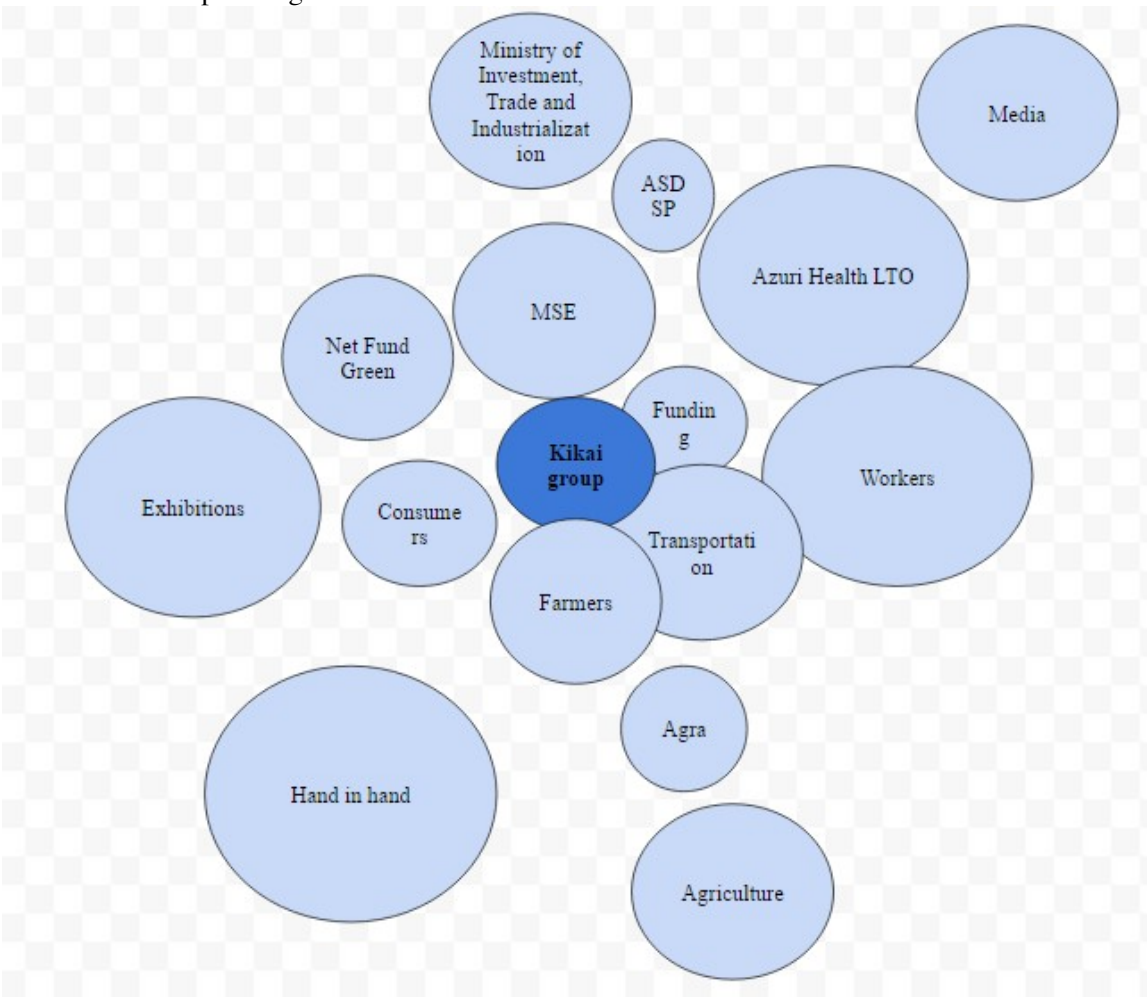
Inputs related questions

38. How you get your inputs for your farm?

39. In case you obtained input through subsidized purchase or donation, please specify the source
40. How have prices for inputs changed during the last three to five years?
41. Do you have storage for macadamia nuts? If so, for how long?
42. If your answer to question is no, why not (I don't know its benefit, I don't have money to invest in creating it, I don't need it since I sell my product immediately)?

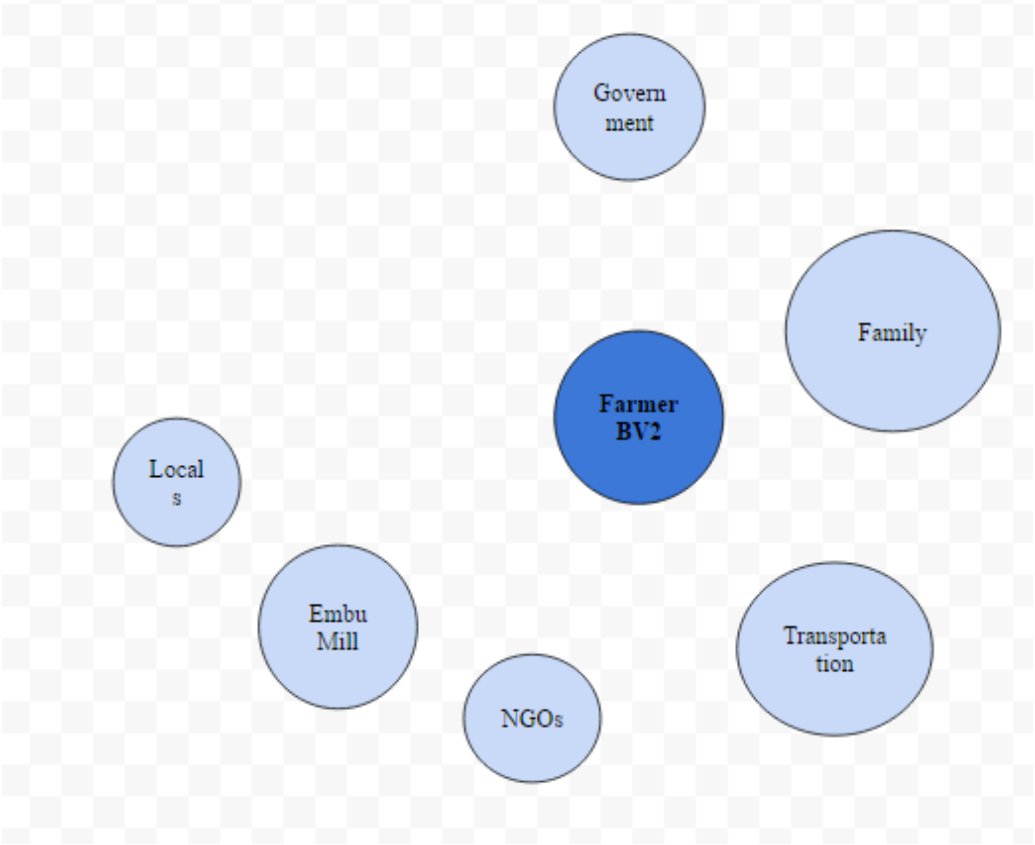
## Appendix 7: PRA table - Chapati Diagram Kikai Foods

Kikai Foods Chapati diagram




Out of this group the most important stakeholders for Kikai Foods (including VA3) are Net Fund Green, exhibitions, workers, Hand in Hand, Azuri Health LTO, the Ministry of Investment, Trade, and Industrialization and the media. Family and transportation (motorcycle) he considers as the main actors for his business. Government and the mill in Embu, of secondary importance. NGOs and locals are seen as the most distant but also of lesser importance to the farmer.

Appendix 8: PRA table - Chapati diagram by farmer BV2



## Appendix 9: PRA table - Ranking exercise

| Ranking exercise | Coffee | Macadamia | Banana |
|---|---|---|---|
| MN1[1] | | | |
| Food | 1 | 1 | 5 |
| Income (cash) | 6 | 4 | 1 |
| Low labour requirement | 1 | 5 | 2 |
| Palatability | 1 | 1 | 5 |
| Easy cooking process | 1 | 1 | 5 |
| Harvestings categories | 6 | 4 | 1 |
| Storability | 1 | 1 | 2 |
| Post-harvest losses | 1 | 2 | 5 |
| Total score | 18 | 19 | 26 |
| NV1[2] | | | |
| Food | 1 | 1 | 7 |
| Income (cash) | 7 | 3 | 1 |
| Low labour requirement | 1 | 1 | 7 |
| Palatability | 1 | 2 | 7 |
| Easy cooking process | 1 | 1 | 7 |
| Harvestings categories | 7 | 3 | 3 |
| Storability | 1 | 1 | 1 |
| Post-harvest losses | 7 | 7 | 3 |
| Total score | 26 | 19 | 36 |
| Average total score | 22 | 19 | 31 |

Deviation from average farmer:

[1] MN1 attained a tertiary level of education, his income exists above average in the 10,000-25,000 bracket, but the rest of his farm is a reflection, or shows little deviation from the typical Kibugu farmer.

[2] NV1 household is undersized (2) in comparison to the typical Kibugu farmer, which is the primary deviation from the typology.

## Appendix 10: PRA table - Seasonal Calendar Banana - Farmer BV1

| Activity | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Post-harvest losses | | | | | | | | | | | | |
| Labour | | | | | | | | | | | | |
| Income | | | | | | | | | | | | |
| Sales | | | | | | | | | | | | |
| Processing | | | | | | | | | | | | |
| Storage | | | | | | | | | | | | |
| Self-consumption | | | | | | | | | | | | |
| Harvest | | | | | | | | | | | | |
| Pest/Disease | | | | | | | | | | | | |
| Pesticide | | | | | | | | | | | | |
| Manure | | | | | | | | | | | | |
| Climate | D | D | D | R | R | R | R | D | D | R | R | D |
| | J | F | M | A | M | J | J | A | S | O | N | D |

D = Dry

R = Rain

Appendix 11: PRA table - Seasonal Calendar Macadamia - Farmer MN2

| **Activity** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Post-harvest losses** | | | | | | | | | | | | |
| **Labour** | | | | | | | | | | | | |
| **Experience** | | | | | | | | | | | | |
| **Income** | | | | | | | | | | | | |
| **Sales** | | | | | | | | | | | | |
| **Processing** | | | | | | | | | | | | |
| **Storage** | | | | | | | | | | | | |
| **Self-consumption** | | | | | | | | | | | | |
| **Harvest** | | | | | | | | | | | | |
| **Pest/Disease** | | | | | | | | | | | | |
| **Pesticide** | | | | | | | | | | | | |
| **Manure** | | | | | | | | | | | | |
| **Climate** | D | D | D/R | R | R | R | R | D | D | D/ R | R | R |
| | **J** | **F** | **M** | **A** | **M** | **J** | **J** | **A** | **S** | **O** | **N** | **D** |

D = Dry
R = Rain

# Appendix 12: Calculations

**Table 2: Price (KES) per bundle banana**

VA1 sells her ripened bananas for 80-120 KES per kg. According to reference.com an average bundle weighs between 15-20 kg per bundle, thus VA1 earns 1,200-2,400 KES per bundle (Table 2):

80 KES/kg * 15 kg/bundle = 1,200 KES/bundle

120 KES/kg * 20 kg/bundle = 2,400 KES/bundle

According to Kikai Foods, 4 kg of flour or 3.5 kg of crisps can be produced from 1 banana bundle. Kikai Foods sell their flour for 250 KES per kg (their main buyer gets a discount and pays 180 KES per kg) and their crisps for 556 KES per kg. This gives an income of 1000 KES per bundle when sold as flour and 1944 KES per bundle when sold as crisps:

250 KES/kg * 4 kg/bundle = 1000 KES/bundle

556 KES/kg * 3.5 kg/bundle = 1944 KES/bundle

Kikai Foods sells on average 70% of their banana production as banana flour per month and the rest as crisps (cakes are rarely sold and therefore not added to this calculation). The average price per bundle banana after processing is therefore as follows:

0.7 * 1000 KES/bundle + 0.3 * 1283 KES/bundle = 1283 KES/bundle (Table 2)

Using Kikai Foods' amount of flour and crisps produced from one bundle banana, VA2 has a income of 800 KES per bundle when sold as flour. The income from banana crisps is unknown. Therefore the price per bundle banana VA2 gets is a minimum of 800 KES per bundle (Table 2).