An Exploratory Study on how the Community of Rusinga Island (Kenya) can Organize Money Saving to Maintain Solar Powered Mosquito Trapping Systems

By

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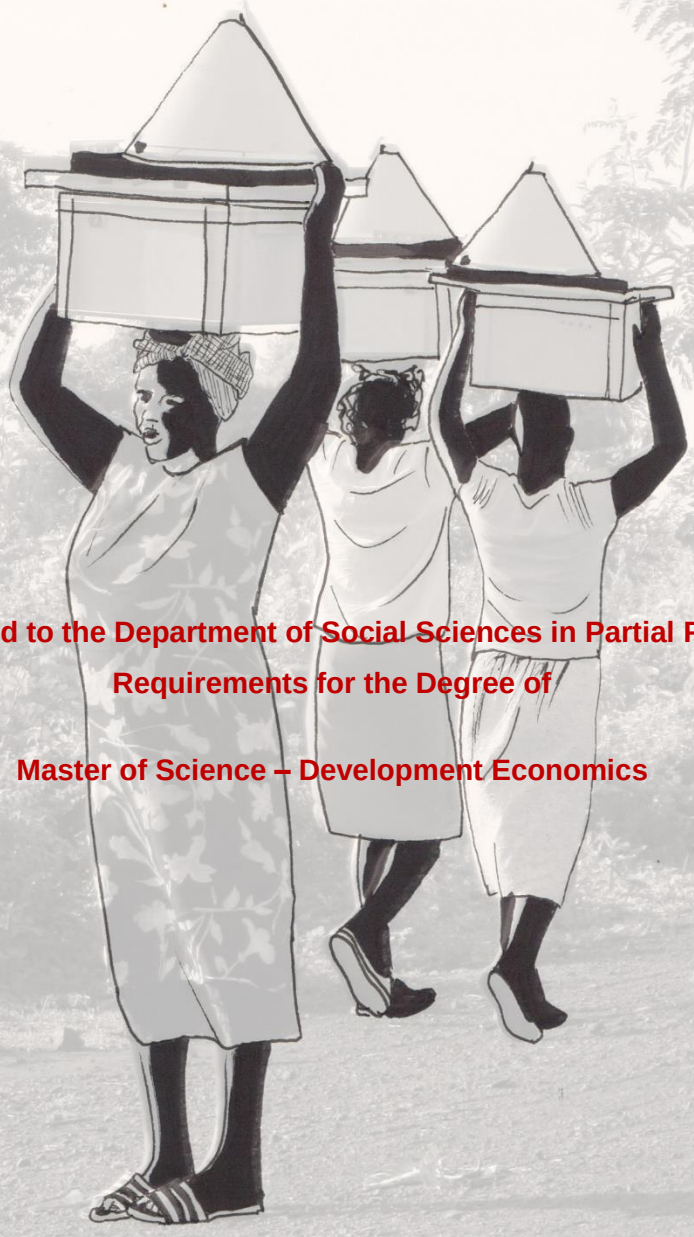

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Abstract

The efforts to control malaria - a mosquito-borne infectious disease - are highly dependent on insecticides. Due to the combination of widespread mosquito resistance and high levels of malaria transmission in large parts of the world there is an urgent need for new approaches for malaria control. The SolarMal project has developed such a new approach; a solar powered insecticide-free mosquito trapping system (SMoT). The SMoTs are being installed free of charge on houses at Rusinga Island, a small island in Lake Victoria, western Kenya, to demonstrate proof of principle for the toxic-free control of malaria. The aim of this study is to research how the community of Rusinga Island can organize money saving to maintain the SMoTs beyond 2015 when the SolarMal project ends. First, it analyzes households' perception of the SMoT and their willingness to pay for maintaining it. Subsequently, it researches how households can be enabled to save money consistently. The results indicate that the general perception of the SMoT is positive and that households are willing to pay to maintain (parts of) the SMoTs. It was found that there are sufficient saving options available for the community to use, although both demand and supply side saving barriers exist. Moreover, due to the heterogeneous character of the Rusinga Island population there exists no single most suitable saving option.

Keywords: Malaria, Kenya, Solar Powered Mosquito Trapping System, Preventive Health Measures, Saving, Willingness to Pay

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Acronyms

AIDS	Acquired Immunodeficiency Syndrome
ATM	Automated Teller Machine
ATP	Ability To Pay
CMV	Contingent Valuation Method
FGD	Focus Group Discussion
HDSS	SolarMal Health And Demographic Surveillance System
HIV	Human Immunodeficiency virus
LED	Light-Emitting Diode
ICIPE	International Center for Insect Physiology and Ecology
IRS	Indoor Residual Spraying
ITN	Insecticide Treated Mosquito Net
KCB	Kenya Commercial Bank
Ksh	Kenyan Shilling
KWFT	Kenya Women's Finance Trust
KYC	Know Your Costumer
MFI	Microfinance Institution
NGO	Nongovernmental Organization
ODK	Open Data Kit
PCA	Principal Component Analysis
ROSCA	Rotating Savings and Credit Association
SMEP	Small and Micro Enterprise Programme Microfinance Bank
SMoT	Solar Powered Mosquito Trapping System
SMS	Short Message Service
WHO	World Health Organization
WTP	Willingness To Pay

1. Introduction

The Malaria burden

Malaria is a parasite that still causes a lot of death and economic damage in large parts of the world. According to the World Health Organization (2013) 627.000 people – mostly children below the age of five – died in 2012 due malaria infection. Every year around 207 million people contract malaria, while 1.2 billion people (roughly 17% of the world population) are at high risk being of infected.

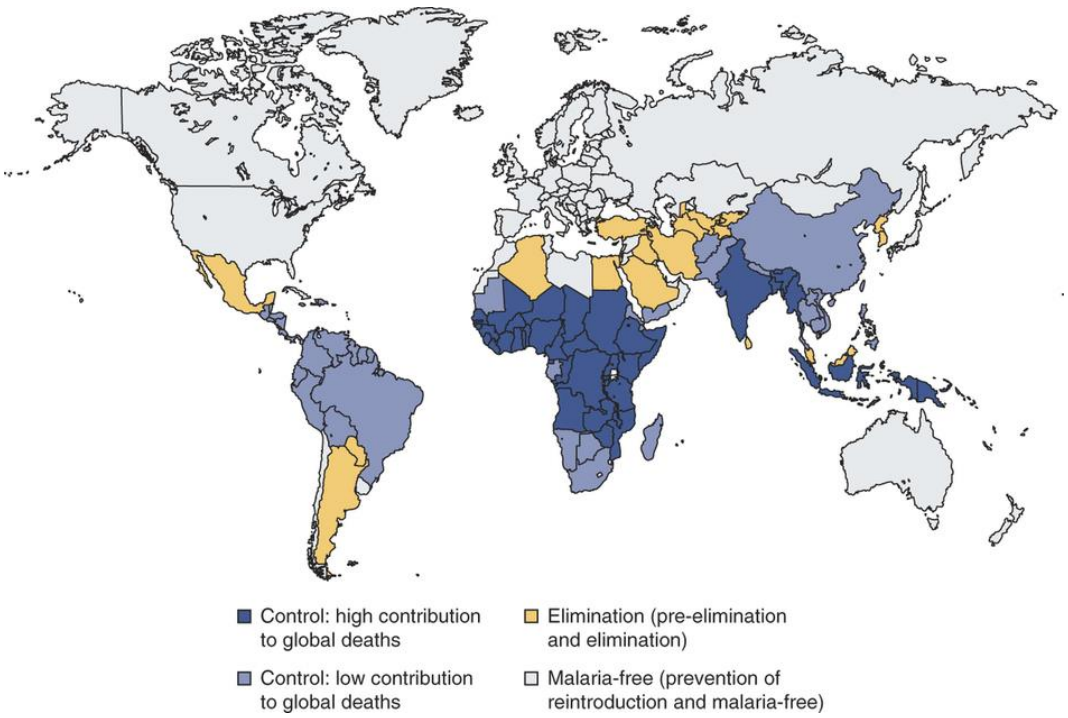

Fig. 1 – *Malaria distribution worldwide and the malaria burden stages of countries (Alonso & Tanner, 2013)*

As can been seen in figure 2, people living in the poorest countries are especially vulnerable; about 90% of all malaria deaths occurred in the African region. The annual financial burden of malaria in Africa amounts to an estimated 8.7 billion euro, mainly due to loss of labor and household expenditure (World Health Organization, 2013). For small-scale farmers in rural Kenya, treatment costs have been estimated as high as 6% of the monthly household expenditure, excluding costs for prevention measures (Chuma, Thiede, & Molyneux, 2006).

Malaria is a mosquito-borne infectious disease caused by parasitic protozoans (a single cell microorganism) of the *Plasmodium* genus. Commonly, malaria is transmitted by the bite of an infected female *Anopheles* mosquito. When a person is bitten, the parasites from the mosquito's saliva enter the blood and then travel to the liver where they mature and reproduce. Malaria causes symptoms that typically include fever, fatigue, headaches and vomiting. In severe cases it can cause seizures, coma and eventually death. Symptoms usually begin ten to fifteen days after being bitten.

Fighting malaria is first and foremost complex because it is not a single disease. The five *Plasmodium* species (*falciparum*, *vivax*, *ovale*, *malariae*, *knowlesi*) that cause human malaria are transmitted by more than 30 *Anopheles* mosquito species which all have different breeding and feeding habits, resulting in different disease spectra in different populations and epidemiological settings. Moreover, current malaria control and elimination programs face heterogeneity of transmission dynamics of malaria in endemic areas, including differences in parasite, human, vector, social and environmental factors. Third, operational limitations exist in the form of failing health services, lack of political will and insufficient financial, social and human recourses. All of 103 countries that currently experience malaria transmission, experience different combinations of these problems (Alonso et al., 2011; World Health Organization, 2013).

In the past decade there have been tremendous efforts to control malaria, especially through indoor residual spraying (IRS) and the distribution of insecticide treated mosquito nets (ITNs) which are currently the most cost effective and sustainable methods for protection against malaria. By 2012, 34 countries in the African region and 83 countries worldwide had adopted the World Health Organization (WHO) recommendation to provide ITNs to all persons at risk for malaria. Today, a total of 88 countries, including 39 in Africa, distribute ITNs free of charge. As a result, the percentage of sub-Saharan African households owning a ITN has risen from 3% in 2000 to 53% in 2012 and in the same time period malaria-related mortality rates fell by 26% resulting in an estimated of 3.3 million deaths averted (Alonso & Tanner, 2013; World Health Organization, 2013).

Despite these accomplishments there is reason to be worried as it has been found that mosquitoes in multiple locations have developed insecticide resistance. Moreover, although four classes of insecticides are currently used, malaria control relies on mostly one type of

insecticide, the pyrethroids (others are organochlorines, organophosphates and carbamates). Introduced in the 1970s, they account for 75% of the total IRS and are used in all ITNs. The high dependence of modern malaria control on pyrethroids puts current global malaria control efforts at high risk; 64 of the 103 countries that experience malaria transmission are reporting mosquito resistance to at least one insecticide used for malaria control, with most of the reports including pyrethroids. In particular western and central Africa, and India, are areas of great concern. Due to combination of widespread resistance – in some areas to all classes of insecticides –and high levels of malaria transmission there is an urgent need for new approaches for malaria control (Alonso et al., 2011; Alonso & Tanner, 2013).

Introducing the SolarMal project

One new approach has been developed by researchers from Wageningen UR (Netherlands) and the International Center for Insect Physiology and Ecology (ICIPE, Kenya) under the name SolarMal. Together with Biogents AG (Germany) and Siempre Verde (Netherlands) they created a solar powered insecticide-free mosquito trapping system or SMoT. Each SMoT consists of one small solar panel, one battery, one mobile phone socket, two light bulbs and one mosquito trap. The trap contains a mixture of human skin scent mimics which lure mosquitoes into the trap where they die from heat and dehydration. By using the trap, a significant reduction in mosquito bites could be achieved as capturing the mosquitoes disrupts their breeding cycle which leads to a reduction in mosquito population size (Hiscox et al., 2012).

In order to demonstrate proof of principle for the toxic-free control of malaria, Wageningen UR and ICIPE started the SolarMal project on Rusinga Island, a small island in Lake Victoria, Western Kenya, in 2012. Funded by the Dutch philanthropic COmON Foundation, 4,000 SMoTs are being installed free of charge from 2013 onwards. In 2016, the SolarMal project will end and the Rusinga community will become the owners of the 4,000 systems. However, there exists a knowledge gap whether the community is willing and able to save money with the purpose to invest in maintaining the systems. The aim of this explorative study is to research how the community of Rusinga Island can organize money saving to maintain the SMoTs. As such, it is part of the broader question on how to sustain the SolarMal project beyond 2015.

Research objective and questions

The focus of this research is two-fold. First, the aim is to gain insight in how households perceive the SMoT, how much money they save using the SMoT and in households' willingness to pay (WTP) for maintaining the SMoTs. Second, assuming that households are willing to pay, it will focus on which saving options are accessible on Rusinga Island and which saving option is the most suitable to use to enable the community to save money consistently in order to maintain the SMoTs. Throughout this thesis, special emphasis will be on the trap as a preventive health measure, as this is the main component of the SMoT from the perspective of malaria control under the SolarMal project.

The following sub-questions will be answered: (1) How do households perceive the SMoT? (2) Which monetary savings can be attributed to the SMoT? (3) How much money are households willing to pay to maintain the SMoT? (4) Which saving options are accessible on Rusinga (5) What is the most suitable saving option in order to enable households to maintain their SMoT?

Outline

The remainder of this thesis consists of six chapters. Chapter two reviews existing literature on saving in low-income countries and the role of saving in household investment behavior in preventive health measures. Chapter three provides background information about the research area and the SolarMal project. In chapter four the research methodology and methods of data collection and analysis are given. Chapter five will present the results. Chapter six will provide discussion of the results and concluding remarks. The closing chapter, chapter seven, will present thirteen recommendations to help direct the thinking on how to sustain the SolarMal project beyond 2015.

2. Theoretical framework

Saving is vital to households and societal welfare. On the individual level savings enable households to smooth consumption and to invest money in physical and human capital. On a macroeconomic scale, saving rates are an important indicator for economic growth (Karlan, Ratan, & Zinman, 2014).

Yet, despite the importance of saving, barriers to save exist for many, especially for those living in low-income countries. In 2012, 36% of the adult population worldwide report having saved in the past year and only 24% of people living in low-income countries report having an account at a formal financial institution (Demirguec-Kunt & Klapper, 2013). Market imperfections such as transaction costs, trust issues and regulatory barriers obstruct the supply of saving products. Various demand-side constraints, such as lack of financial knowledge and behavioral biases, depress saving even more among those who have access to saving products (Karlan et al., 2014).

Despite these barriers, household surveys show that the poor have a substantial (latent) demand for saving. Even the poor living on less than $2 a day have some surplus which they use for non-essential expenditures, and although many do not own a formal account, people do save using livestock, under matrasses and/or in informal groups (Abhijit Banerjee & Duflo, 2007; Karlan et al., 2014).

A growing body of evidence from field experiments indicates that removing barriers to saving in low-income countries can improve household welfare greatly, and as a result saving is becoming a priority in the development agenda (Ashraf, Karlan, & Yin, 2006; Brune, Giné, Goldberg, & Yang, 2011; Dupas & Robinson, 2013b; Prina, 2013). Following Karlan et al. (2014), I will group potential explanations for ‘undersaving’ in to five categories. Undersaving means a lower level of saving than would occur in a world with perfect markets (perfect competition, zero transaction costs, perfect information) and a fully rational, fully consistent decision-making. The five categories are: (i) transaction costs, (ii) lack of trust and regulatory barriers, (iii) information and knowledge gaps, (iv) social constraints and (v) behavioral biases.

Saving barriers in low-income countries

Transaction costs

To generate a perfect market, a market that maximizes social welfare, zero transaction costs are crucial. However, accessing and using formal financial products costs involves monetary costs such as account opening fees, withdrawal fees, monthly bank pass fees or transportation costs for accessing the physical building of the financial institution. These costs can be a major barrier for people to access and use formal products, especially when the fees are a large portion of ones savings (Karlan et al., 2014).

It has been shown that subsidizing the costs of opening and maintain a bank account can increase the take-up of formal saving accounts. A study in the rural Western part of Kenya finds that eliminating opening costs substantially increases the opening of formal bank accounts among market vendors and micro-entrepreneurs (Dupas & Robinson, 2013a). The intervention did not have the same significant impact on bicycle taxi drivers. To improve the external validity of the study, more studies are being conducted in Chile, Malawi and Uganda to examine whether relaxing the opening fee constraint leads to a higher take-up of formal saving accounts also in other contexts.

In another similar field experiment, Prina (2013) also found strong evidence from eliminating account opening costs among a general sample of 1,118 poor households living in 19 slum settlements in Nepal. The participants that were given access to free saving accounts accumulated significant more wealth, increasing monetary assets by 25% and non-monetary assets by 12% over the control group. Moreover, households in the treatment group spent 20% more on education and 15% more on meat and fish.

Even though these results are promising, both studies mention that the take-up and usage rates of the free accounts could be higher. In the study of Dupas and Robinson (2013a), 47% of 156 treatment group individuals that were offered a free account opened it and used it at least once. In the study of Prina (2013) the figures are higher but still show there is room for improvement; 84% of 567 of the individuals that were offered a free account opened one and 80% used it frequently (making at least two deposits over a one year period). An explanation for the lack of usage could be that heterogeneity in valuation or heterogeneity in other constraints exist. For example in Kenya, Dupas, Green, Keats, and Robinson (2012) find that risk of embezzlement,

unreliable services and ongoing high transactions costs are listed by some respondents in dealing with formal bank accounts. Also in Kenya, Schaner (2013a) finds that intra-household bargaining issues may drive heterogeneous responses to reductions in transaction fees.

Not only monetary costs can discourage households to use formal bank accounts. Non-pecuniary costs such as travel and opportunity costs in terms of time and foregone wages can have significant impact as well. However, these costs can be difficult to quantify. Randomizing bank branch expansion and measuring impact on saving take-up and household welfare is often not feasible, but some studies have found ways to work around this issue. In Malawi, Flory (2011) takes advantage of a field experiment to study the effect of bringing banks closer to people through the introduction of a fully equipped mobile van, 'bank on wheels'. Using a two-year panel data set containing 2,600 households, he found that the take-up rate for bank accounts remained low, from 9.3% to 12.4% across all treated areas one or more kilometer away from the van and from 8.6% to 12.3% in treated areas that were three or more kilometers away from the van.

Schaner (2013a) finds a stronger effect; saving transactions increase significantly from expanded geographical access via bankcards that access an ATM network, though in this case it is unclear whether the effect is driven solely by non-pecuniary costs as the bankcards reduce marginal transaction costs as well. More research that combines pecuniary and non-pecuniary costs seems necessary.

Lack of trust and regulatory barriers

Trust may also be an important explanation for the deficiency in the relation between savers and financial institutions. Lack of trust affects the willingness of individuals to use a particular institution. It affects economic transactions between parties as it acts as an implicit cost due to moral hazard, which in turn leads to increased monitoring and enforcement costs or unconsummated transactions (Karlan et al., 2014).

Sufficient behavioral economics literature exists that researches trust experimentally in lab settings in order to see how trust influences risk-taking (see Karlan, 2005; Schechter, 2007). However, there are no random field trials to date that study the relationship between low trust and formal banking services and one important reason for this is that one cannot easily randomly assign trust (Karlan et al., 2014).

With a sample of 1565 individuals, Dupas et al. (2012) find reasonable take-up of free savings accounts (62%) but much lower active usage (18%). A qualitative survey on a subset of participants finds that trust is often cited as a key concern. Of those who did not open or use the free savings account 15-37% cited unreliability as a concern and 7-28% mentioned risk of embezzlement by the given bank. In contrast, Djankov and Sharma (2008) conducted a survey on 4,765 Mexican households of whom 2,182 did not have a bank accounts. When asked for their reasons not having an account, only 2% of the unbanked households mentioned not trusting the financial institution.

Clear from the literature is that there are many factors that influence trust in a financial institution such as brand, reputation, product quality and price. Governments are thought to play a central role in building and maintaining client trust as they formulate the contractual context in which clients and institutions operate (Porta, Lopez-deSilanes, Shleifer, & Vishny, 1999). Such regulation has two basic goals: (1) to protect clients from losing their savings and (2) to ensure trust in the financial system as a whole (Conroy, 2002). Nevertheless, for the poor such regulation can be a key barrier to use a formal account, especially since financial regulations are becoming stricter which leads to the imposing of additional transaction costs for banks and customers.

Today, banks are required to follow strict guidelines known as 'know your customer' (KYC) rules which often hinder the poor. When opening an account, banks ask costumers to provide specific identification documents including proof of name, date of birth, national identity number and residential address. Banks also need to collect pre-determined information about clients and monitor account activities. While such regulation may be necessary in supporting trust and stability, it discourages at the same time small savers, particularly poor individuals with few formal documents. The identification document requirement can be a big hurdle in low-income countries which often lack comprehensive registration identify registries. Waiting periods to process KYC rules function as a barrier in its own right (Karlan et al., 2014).

In a study on the impact of KYC rules in the US among Mexican immigrants, Chin, Karkoviata, and Wilcox (2011) offered assistance and a fee waiver (of $27) to 99 randomly chosen individuals to help them obtain an identification card from the Mexican consulate which is (only) useful for immigrants to open a formal saving account. The control group, which consisted of 85

people, received no help. The researchers find that those in the treatment group were 38% more likely to have increased their savings over a 5-month period after the intervention and that the treatment group saved 9% more than the control group. Further research is necessary to see whether these results would replicate (Karlan et al., 2014).

Information and knowledge gaps

Lack of information or 'low financial literacy' is often cited as one of the main causes of undersaving. Policy and intervention efforts that aim to improve financial literacy are based on three assumptions: 1. Financial knowledge is low; 2. This causes undersaving; 3. Interventions can increase knowledge cost-effectively (Karlan et al., 2014).

Is basic financial knowledge low among residents of low-income countries? Many recent studies suggest 'yes'. During a four question survey in India, 26% of the respondents did not correctly answer the four basic multiple choice questions and only 3% answered all questions correctly (Cole, Sampson, & Zia, 2011). Another study finds similar results using the same survey instrument in other less developed countries (Xu, 2012).

Does lack of knowledge causes undersaving? Empirically speaking, this link looks very weak, although there is evidence from household surveys that there exists a strong correlation (Hastings, Madrian, & Skimmyhorn, 2012). However, this correlation does not imply there is causality between low financial literacy and undersaving. Evidence suggests that financial literacy is correlated with important variables such as cognitive capabilities that are often left out due to data constraints. Reverse causality is also a concern, where saving more increases financial literacy rather than the other way around (Fernandes, Lynch, & Netemeyer, 2014; Karlan et al., 2014).

Say that financial literacy is important to improve saving, despite the lack of strong evidence; which interventions increase financial knowledge? And are these interventions cost-effective? Mounting evidence on these questions is not very encouraging. In a thorough meta-analysis of 168 papers, Fernandes et al. (2014) conclude that temporarily implemented financial education does not lead to substantial behavior change. What is more is that they find that many financial education programs have small to no effects and are unlikely to pass a cost-benefit test.

Despite these conclusions, there are a few glimmers of insight for rethinking approaches to go forward. First, several studies find heterogeneous effects, which shows the importance of matching content with recipients (Seshan & Yang, 2012). Second, there has been relative little focus thus far on youth but financial education programs for children show promising results in regard to increasing the financial knowledge of participants (O'Prey & Shephard, 2014). Third, it seems that less is more. Interventions designed to improve financial literacy are almost always programmatic. They range in duration from an hour to several weeks and are delivered in settings raging from bank branches to classrooms. However, the most promising results come from programs that are either very simple in terms of content or short in terms of total time commitment (see for example Drexler, Fischer, & Schoar, 2014; Seshan & Yang, 2012). Timing, specificity and framing of the content is thus likely more important than comprehensiveness which is often aimed for in programmatic interventions (Fernandes et al., 2014).

Social constraints

Historically, the dominant mechanism for households and individuals to smooth their consumption and cope with shocks has been to turn to financial support provided by family and friends. These social, informal ties foster risk sharing within and across households. However, such social links can also be restricting (Karlan et al., 2014).

Within a household, barriers to save can exist when its members have different spending preferences. For example, variations in the preferences of males and female heads of households can have large effects on the saving and investment behavior of the household. This in turn has implications for savings product design (Karlan et al., 2014).

There are several studies which empirically test how heterogenic preference within a household affects household saving behavior. In Kenya, among 142 couples, Robinson (2012) randomly gave either a husband or wife a small, positive, public income shock of 150KSh once a week for eight weeks in a row. Every week, the husband and wife had 50% chance of being chosen to receive 150KSh. He found that husbands increased their expenditures on privately consumed goods in the weeks after they received a higher income. Women, in contrast, did not increase their expenditures both when they or their husband received the shock. As they transfer only 16.7% of the extra income to their husbands, it suggest that women save the rest. In another experiment, Schaner (2013b) finds that household saving is increasing when couples are well-matched, or more specifically in how associatively matched they are on their individual discount

rates. When they were offered subsidized joint accounts, they responded much more to variation in rates of return. Lastly, in a follow up on a large study offering a commitment savings account (SEED) in the Philippines Ashraf, Karlan, and Yin (2010) found that women offered the account increased their scores on an index measuring household decision-making by 0.14 standard deviations over the comparison group. Heterogeneous impacts by bargaining power were important, with an increase in female-oriented durable goods purchased in households where women had below-median decision-making power at the baseline.

Between households, family and community networks are important for risk-sharing in low-income countries (for an in-depth review see Robinson, 2012). But the implications of these networks for optimal saving rates and saving behavior are complex; for example, a well-functioning risk-sharing network reduces the need for precautionary savings (Karlan et al., 2014). There is – mostly descriptive – evidence from anthropology but increasingly from economics as well that wealthier households are pressured to support those in their network who are less-well-to-do. However, the links between this pressure and saving behavior are not clear at all. Do claims on wealthier people function as a tax on household savings and wealth accumulation? Do concealment and commitment devices reduce the depressive effects of such as tax? If so, at what cost?

Most studies try to disentangle the implications of social- vs. self-control motives for saving behavior through lab experiments in the field (see Chandrasekhar, Kinnan, & Larreguy, 2014; Gine & Mansuri, 2014; Jakiela & Ozier, 2012). One important aspect these studies suggest is that people use credit as a way of sending a message to their social networks that they are too poor to have any saving.

In their study on the impacts of reducing the costs of accessing a basic savings account in Kenya, Dupas and Robinson (2013a) found that the cheaper accounts led to substantial increases in microenterprise investment and expenditures while no interest was being offered and despite withdrawal fees being charged. As they are unable to validate any mechanism, they discussed the possibility of social pressure, risk-aversion or time-inconsistence driving this result. However, in another experiment using a commitment treatment, Brune et al. (2011) found little evidence to support the importance of 'other-control' motives such as social pressure. In all, there is evidence from different settings that social claims induce individuals to develop strategic behavior, but the results are more suggestive than definite.

Behavioral biases

Empirical research has shown that people struggle with self-control in many domains; overeating, oversnoozing and undersaving have all been attributed to the human tendency to 'live for today'. Economists have formalized this *carpe diem* tendency in a 'multiple-self' framework, where the 'present-self' may eat that extra piece of cake while assuming that 'future-selves' will not (Karlan et al., 2014).

With regards to saving, models of costly self-control deliver the key prediction that individuals who are (partly) sophisticated about their carpe diem tendencies will choose, and even pay, to restrict the actions of their future selves. The intuition is that today's self is very impatient when it comes to the trade-off between today and tomorrow, but patient between the trade-off between tomorrow and any future period. If today's self understands that in the future it wants to deviate from its carpe diem tendency, it may want to make a *commitment* that makes deviating costly. This demand for commitment is absent in standard models of intertemporal consumer choice, where preferences are time-consistent; if I make plans I stick to them unless something in my choice set changes that will result in me re-optimizing my plan (Karlan et al., 2014)

Commitments basically come in two forms; *soft commitments* and *hard commitments,* although this is really a spectrum and there exist a lot of different devices. When failure or rewards for success are followed by an economic penalty it is a hard commitment, while devices that have primarily a psychological consequence are considered soft commitments.

The first field experiment on a hard commitment device to improve saving was developed by Ashraf et al. (2006). Together with a bank in the Philippines they created a product that offered the choice of two commitment features to a sample of existing clients: either a time-based maturity, in which people could only withdraw their money after a certain time period, or an amount-based maturity, in which people could withdraw their money only after they reached a specific target. After one year, individuals in the treatment group increased their savings with 411 pesos or 82% compared to the control group who did not use any commitment feature, and in line with self-control theory, individuals identified as time-inconsistent were most likely to show a preference for and benefit from the commitment device. Still, the devices did not cause a lasting behavioral change as the longer-term impact on saving balances over a two and a half year time period (a 33% increase) was no longer statistically significant.

In Kenya, Dupas and Robinson (2013b) conducted the first field experiment looking at the effects on behavior using different types of commitment devices. They randomized members of existing rotating savings and credit associations (ROSCA's) (groups of people whom save together) in five groups and offered two groups a soft-commitment device and two groups a hard-commitment device. The fifth group was the comparison group. The study is particularly interesting because it shows the presence of all three types of saving barriers: intra-personal, inter-personal and intra-household. Intra-personal barriers seemed to matter significantly; those who were time-inconsistent were not able to benefit from a soft-commitment device because it was too easy for them to access the money. But they also did not benefit from a hard-commitment device since there was no incentive to use the device in the first place, because their savings became illiquid. However, they did benefit from a stronger commitment and social pressure facilitated by starting a common pot. Brune et al. (2011) find similar results in Malawi and it seems that hard-commitment devices that tie the saver's hand to a specific goal are less effective than commitment devices that allow for some flexibility. Given the risks and uncertainties households face in low-income countries, the option to withdraw money when needed may outweigh the benefits of committing to long-term savings.

Although the handful of field studies on commitment devices mostly focus on the development of new saving products it is important to note there are already established products that attribute to commitment features, most notably group saving. In western Kenya, both Dupas and Robinson (2013b) and Gugerty (2007) find evidence that ROSCAs can be effective for people to commit themselves to save, mostly through the mechanism of peer pressure. Also Kast, Meier, and Pomeranz (2012) find that informal self-help peer groups are a powerful tool to increase savings, even without physical meetings but through feedback text messages. On the other hand, Anderson, Baland, and Moene (2009) argue that informal ROSCAs are never sustainable unless there is an external (social) sanctioning system with sanctions on their members that are sufficiently high. Despite the ongoing popularity of ROSCAs much remains to be identified about how peers influence saving behavior (by providing information? soft-commitment?) and how the transaction costs (regular group meetings cost a lot of time) can be lowered.

Wrapping up and moving forward

What can we say about the evidence so far? Is there a recognizable pattern of results that tells something about the importance of constraints to saving among poor households? Do we

understand which of the five classes appears to be most binding and has the largest welfare implications? It is important to emphasize that almost every study falls short of welfare analysis as they only measure short-term effects and do not explain anything about net savings or if the individuals' overall financial conditions and well-being improves. There are, however, a few noteworthy patterns that can be identified.

In regard to transaction costs, at least three studies find large impacts of access to subsidized saving accounts on income and overall short-term welfare (Dupas & Robinson, 2013a, 2013b; Schaner, 2013a). The most surprising results come from the study by Schaner (2013a), who finds that even small monetary subsidies given by the researcher to pay for opening fees or minimum balance deposits have a significant impact on the take-up of formal savings accounts. Moreover, it is one of the few studies that finds long-term positive welfare effects due to this small and time bound subsidy. Obviously there is a need for more long-term studies to validate this promising result.

Something that deserves attention as well is the take-up rate of commitment devices and the gap between take-up rate and usage. Take-up rates for commitment products tend to run in the 20-30% range. By the standards of a new financial product launch this is quite high. However, even 20% *could* be too low, especially given the large positive impact of formal (commitment) saving accounts, so the reasons behind possible sub-optimally low take-up is worth further scrutiny. For example, it may be the case that a lack of sophistication (knowledge about one's self-control problems) depresses demand for harder commitments. The higher take-up of softer commitments is in line with this. What is striking though, is that it there often exists a wide gap between take-up and usage rate, i.e. most account-openers do not become account users. Initial usage typically depreciates into inactivity after six months or so (see Dupas & Robinson, 2013a; Prina, 2013) Further studies are needed to analyze the drivers of these patterns. Do transaction costs become more important, for example when subsidies are removed? Do people lose their initial excitement? If so, can follow-up communication strategies (delivered by SMS for example) enable continued engagement with the product? This last point seems the case, as Kast et al. (2012), find that sending reminders through mobile phone texting works to lower transaction costs and increase savings. Moreover, given the relative low costs of digital communication it is a promising technique (see also Jack & Suri, 2014; Karlan, McConnell, Mullainathan, & Zinman, 2010)

A third pattern is that, although maybe counterintuitive, soft commitment products, which allow for some flexibility in how the money ultimately is used, seem to be more effective in many settings than hard commitment devices which tie the saver's hands to a target goal. Both Dupas and Robinson (2013b) and Brune et al. (2011) find more money saved towards health and agricultural investments through the more flexible commitment products offered. Given the risk and uncertainties that poor household's face, the option value of withdrawing money when needed may outweigh for many the benefits of committing to long-term savings. The evidence suggests that if the price of vice – in the case of savings the vice is the withdrawal of funds – is too high, the participation constraint will bind so that people will not open or use the account. To be state-contingent, people want to increase the future price of vice but in the case of an emergency, they want flexibility.

Fourth, nearly every study highlights the influence heterogeneity of some form has on impacts of saving products as it seems that the effectiveness of products depends to a large extent on who its users are. The different preferences of financial decision-makers in a household – often the female and male heads of the household – results in strategic behavior. The results so far suggest that intra-household bargaining power heterogeneity depresses saving rates. At the same time, commitment saving products that restrict easy access to savings seem to improve both women's ability to save and their decision-making power.

Fifth, in regard to financial literacy there is little evidence that the increasingly widespread comprehensive programmatic approaches to build financial literacy are (cost-) effective at improving saving behavior. Short-timed, comprehensible programs seem to be more effective.

And lastly, the results of peer influence on savings decisions coupled with the popularity of ROSCAs and other informal group-based saving mechanisms shows the potential for unlocking the power of peers. However, much remains to be identified about when and how peers influence savings decisions; by providing information? Attention? Soft-commitment? Or through other mechanisms?

Investing in preventive health measures and the roles of information and saving

Understanding the above described patterns is crucial as saving plays a key role in household investment behavior in preventive health measures in low-income countries. In essence, investment behavior in health measures is characterized by two stylized facts: (1) households spend a significant portion of their resources on remedial health care and (2) they invest little in preventive health care. Savings barriers are at the root of low levels of preventive health care investments.

High level of remedial health care investment

The high cost of treatment relative to household income and the general lack of health insurance are the two main reasons why health expenditures are relatively high in low-income countries. Duflo, Banerjee, Glennerster, and Kinnan (2013) find that out-of-pocket health expenditure represents about 10% of total household expenditure among households living in the slums of Hyderabad, India. In Kenya, Dupas and Robinson (2013a) find that health expenditure represents 8% of total health expenditure. To place these figures into perspective, in the United States, out-of-pocket health expenditure is considered unaffordable if it is more than 5% of the family income (Shen & McFeeters, 2006). In addition, households seem to be pretty price inelastic in regard to medical treatment, probably because choosing for no treatment can cause extreme and immediate suffering. In Kenya, Cohen, Dupas, and Schaner (2014) show that price elasticity appears surprisingly low over a range of moderate prices; when they increased the price of an antimalarial treatment course for young children from $0.30 to $1.5 (250% increase) this did not reduce the share of households buying the treatment. Only at much higher prices demand falls; only 3% of the participating households bought the treatment at $3. Other studies found similar results (see (Lewis, 1991; Sahn, Younger, & Genicot, 2003). Lastly, poor access to the right medical treatment causes cost inefficiencies. In the above described study by Cohen et al. (2014) with around 2,000 households, the authors observe the first typical response of households to symptoms of malaria is to self-diagnose and buy mediation, bypassing the formal health care system. However, using rapid diagnostic test they found that only 37% of the people age 15 years or older for whom a malaria medicine had been purchased tested positive for malaria. The rest of the patients had another illness such as pneumonia and needed a completely different treatment.

Low level of preventive health care investment

But why are households reluctant to invest in preventive technologies and behavior such as bed nets, water treatment products and immunization? This is puzzling, especially given the fact that private returns of preventing disease almost always outweigh the costs. For example, immunization is a highly cost-effective method for improving child survival. Estimations show that every year at least 27 million children worldwide do not receive basic immunizations. As a result, between 2 and 3 million people die from vaccine-preventable diseases (Abhijit Banerjee, Duflo, Glennerster, & Kothari, 2010). Lucas (2010) estimates that the purchase costs of a bed net are much lower than the increase in earnings associated with the cognitive and educational gains due to a reduced malaria burden in early childhood. Still, many people decide not to buy or use a bed net.

Most people mention lack of funds as the main reason why and indeed the demand for such products is rather price elastic (Guyatt, Ochola, & Snow, 2002). For example, in Kenya, Kremer and Miguel (2007) found that the take-up of deworming medication is almost 80% when the drugs were provided for free. It dropped to 20% when the price is raised to $0.30. Also in Kenya, Cohen and Dupas (2010) found that pregnant women universally take up a bed net when it is given for free but only 40% buy one at a – still highly subsidized – price of $0.60.

But there is more to it, which is illustrated by Dupas (2011). Using a simplified budget constraint model, she argues that households make two types of health investment: preventive and remedial. At each moment in time, after observing whether a bad health shock has occurred and the unearned income, a household chooses the level of investment in preventive care, the level of consumption, the level of leisure and the level of investment in remedial care if there was a bad health shock. Thus in this setup, health solely enters as a direct input into the utility function. Of course this is a simplification. In a richer model, health would affect productivity and thereby the wage rate. However, the model helps highlighting three key factors in household health investment behavior

Firstly, investment decisions are affected by the households *level of information*. How much a household invests in prevention depends on their belief that the risk of bad shocks would be reduced through prevention. Likewise, remedial investments will depend on their beliefs about the type of sickness they face and the adequacy of accessible remedial care. Taking this into account, households can under or over-invest in both preventtive and remedial care in the

presence of imperfect information. Second, investment decisions depend on *access to financial markets*. When households lack access to credit, they are unable to borrow money when necessary to invest in preventive health measures and when they do not have access to safe saving technology, they are unable to accumulate money on their own with interest. Lastly, the model shows that preventive and remedial investments enter into the utility function diffrently. The level of remdial health investment chosen in a specific period affects utility directly in that period. With preventive health investments this is not the case as it only enters into future utility levels. This means that preventive health measures decrease faster with the discount rate than remedy investments (Dupas, 2011).

The role of information

A series of recent studies indeed suggests that a lack of information on illness prevention or the effectiveness and cost-effectiveness of preventive behaviors is a possible explanation for why households in low-income countries often underinvest in preventive health care. The findings show that providing information can have a significant impact on health behavior, although the impact depends on what information is given and to whom.

In Bangladesh, (Madajewicz et al., 2007) find that informing households about the unsafe concentration of arsenic in their well water increased the likelihood that they switched to a safer well: 60% of the informed households changed wells compared to only 8% of households in the control group. In Mali, (Rhee et al., 2005) conducted a randomized controlled trial in which households received bed net impregnation services either with or without education, which focused on the symptoms of malaria, transmission and prevention, the benefits of a bed net and how to impregnate nets. They found that, of the households that received the educational service, 49% impregnated their nets compared to 35% of those that did not (for more studies see (Cairncross, Shordt, Zacharia, & Govindan, 2005; Wilson & Chandler, 1993). Overall, these studies suggest that household health behavior is quite responsive to information. However, the source of information has to be credible to make a difference and the impact depends on specific characteristics of the target group. For example, Kremer and Miguel (2007) show that a randomized health campaign aimed at reducing intestinal worm infections among children in Kenya had no effect on children's behavior. A possible explanation is that the campaign was targeted at children instead of the parents which would have likely increased impact. The impact of information might also depend on gender, or more specifically, whether it is targeted to the female of male head of the household. Just as with saving, the unitary model of the household

has been rejected by numerous studies that have shown that mothers or grandmothers spend a higher share of their income to improve child health and nutrition than fathers or grandfathers do (see Duflo, 2003; Qian, 2008). Still, the evidence that women and men value child health differently and therefore respond to information differently is scarce. In Kenya, Dupas (2009) randomly targeted households through a promotion campaign for antimalarial bed nets. Although she did not find systematic gender differences for investment in bed nets, findings suggested that at least for some households, both heads might need to be convinced of the effectiveness of a product before the household invests in it.

Lastly, studies show that access to information is complemented with education and social learning. Schooling can enhance information acquisition and learning. As a result, when facing technology that requires complex processing, individuals with lower education levels might have trouble understanding its workings (Rosenzweig & Schultz, 1989). There is evidence that education matters for health behavior although it is scarce. In Brazil, Thomas, Strauss, and Henriques (1991) found that almost all impact of maternal education on child health could be explained by indicators of access to information (such as watching television, reading the newspaper and listening to the radio). In Uganda, de Walque (2007) found that the response to a HIV/AIDS prevention campaign was faster and more pronounced among the educated.

When learning about the effectiveness of a product or service requires a significant amount of time, households may not only learn for their own experiences but also from others experimenting (neighbors, family or peers). Although such social learning can speed up the learning process compared with learning only by oneself it can also lead to free-riding problems. When healthy behavior comes at a cost – e.g. when it requires a costly tool or technology – people need time to experiment or see others experiment to become convinced of the health returns of the technology or behavior. In Kenya, Kremer and Miguel (2007) found that households were less likely to invest in deworming if they had a higher number of social contacts who benefitted from free deworming programs in the past. This negative effect is consistent with a way of social learning in which people start with overestimating the private returns to adoption. Even though deworming has large social returns (as a health externality), it has low private returns due to high usage costs. People that learned about this high usage costs and low private returns from those who received the subsidy rationally chose not to invest in deworming (Dupas, 2011). In Nepal, Oster and Thornton (2009) find that the adoption of a personal hygiene product (menstrual cups) among adolescent girls increased when a girl had a

greater number of friends who also received the product for free. The study provides evidence that the peer effects operated through learning (how to use the product) and not through norms (making one want to use the product).

The role of financial markets

Although information can make a substantial difference, information alone is not sufficient to achieve optimal preventive health behavior. Preventive health measures can require substantial and lumpy investments by households and for many households living on less than $2 per day it is impossible to quickly outlay large sums of cash. Hence it is likely that – even with full information – demand for these kinds of preventive tools will remain low unless poor households have access to credit and safe saving technology (Dupas, 2011).

In India, Tarozzi et al. (2014) offered people living in a random sample of 47 villages the option to purchase unsubsidized bed nets in cash or on a one-year credit contract. If a net was purchased on a contract the interest rate was 20%. They found that 52% of the households offered a net purchased at least one on credit, whereas only 2% purchased a net in cash. Repayment rates were high; 65% repaid the loan within a year. The large purchase difference can be explained in two ways: First, the households who purchased a net using credit did not have enough money to buy a bed net in cash, but knew they would be able to pay for it within a year (including interest). Or they had the ability to pay for it in cash but preferred to pay in one year due to low immediate costs. Devoto, Duflo, Dupas, Parienté, and Pons (2012) found similar results in Morocco. In 2008, poor households living in Tangiers were offered credit and assistance in linking their home to the national drinking water network which required installing a $500 pipe. Of the total households that were offered credit and information, 69% bought a connection compared to only 10% of the households in the control group. These results suggest that credit constraints are an important barrier for households to invest in lumpy products that can potentially improve health. One interesting question that arises is, if people underinvest in preventive health measures, why are remedial health investments insensitive to credit constraints? A possible explanation is that households are part of kinship and solidarity networks of family and friends. There is evidence that members of such networks insure each other against idiosyncratic shocks (Dupas, 2011; Robinson & Yeh, 2012).

Barriers to saving

Even when households cannot borrow to invest in preventive health products, they should be able to save to acquire these products over longer periods of time. So why do most of them chose not to save? Firstly, households spend so much money dealing with actual health shocks that this can negatively affect their ability to save for the very products (or behavior) that would prevent these shocks in the future, creating a health poverty trap. A related example comes from South Africa, where Case and Menendez (2009) examined the effects of funeral spending on the finances of households. They found that social norms dictated that large outlays of money were common at the time of a funeral, but that such outlays left households financially vulnerable. The more a household spends on a funeral, the lower its investment in child schooling and the poorer its future adult health. Although in this case the problem could be solved by changing social norms and limiting the size of funerals, reducing remedial health expenditures to increase savings toward preventive investment is not always an option (Dupas, 2011).

Secondly, the reasons they chose not save adequately for health were related to the savings barriers described above. Transaction costs, self-control problems, social pressure from others to share cash on hand and financial illiteracy can all play a role in low investment in preventive health measures (DellaVigna & Malmendier, 2006; Dupas & Robinson, 2013b). Hence, identifying and removing these is barriers is vital to ensure preventive investments in health.

3. Research background

Rusinga Island

Rusinga Island is located in Lake Victoria, Mbita division, Western Kenya (0°24′S 34°10′E) (figure 3). The volcanic island, which measures 44m^2, was inhibited by 25,330 people who lived in 7,529 houses and 4,657 households in June 2014 (Hiscox, 2014). Due to the island's close distance to the mainland (figure 4), a 200 meter-long causeway was constructed in 1983 to link the island with Mbita Township. Strictly speaking Rusinga is thus not an island but a peninsula. Rusinga can be reached from Kisumu via a two hour matatu (a small van) and a one hour ferry ride to Mbita. The other access road is from Kisumu or Kisii via Homa Bay on, for the most part, a rough, unpaved road. There is one dirt road encircling the island and primary modes of transport are on foot, by bicycle or piki-piki (motor bike). At the islands' beaches there are a few small shops as well as in the area just of the causeway. Mbita Township is the major trading and administrative center for the surrounding villages and islands. Although the Township is small, there are numerous retail shops, cafes, hotels and bars, as well as a chemist, post office, small supermarket and several banks.

Fig. 2 – *Location of Rusinga Island*

Fig. 3 – *Rusinga Island*

The land on Rusinga is extensively deforested and very rocky. There are river beds running from the hills into Lake Victoria but all are very dry for most of the year. Two previously regular rainy seasons, the long rains from March to June and the short rains from October to

November, have become less and less predictable. The island experiences prolonged dry periods and community members have little faith in the occurrence of the short rains.

Most houses are made from wooden frames smeared with mud/cow dung or corrugated iron, with either reed or corrugated iron roofs. Lake Victoria is the main source of water; the lake is used for washing clothing and dishes, bathing, irrigating farmland and drinking water. Latrine usage is low. Except for a few guest houses, NGO offices, businesses and research facilities there is no electricity or running water. Generators are sometimes used to pump water, run-cell phone charging businesses, power speaker systems for church services and other events or to provide electricity for lighting (see figure 5 for an impression of Rusinga Island and Mbita).

Fig. 4 - *Clockwise: Rusinga Island, road through Mbita Township, Rusinga Island, view from the ferry on Mbita plaza, Kenya (2014)*

The majority of the Rusinga population are Luo and Luo Basuba. The Luo are the third largest of the 43 tribes within Kenya (Central Intelligence Agency, 2014). The Luo tribes' people are River Lake Nilotes who originated in South Sudan and are part of the Bantu/Nilotic mixed race which migrated to western Kenya via Uganda in the 15th century. They were called River Lake Nilotes because they were fishermen from along the River Nile. Their mother tongue is Dholuo but a substantial number of people also speak English, especially the younger generation. Knowledge of the Kiswahili language is limited (Russell, 2009). The sex-ratio of the population is female biased (100 females: 91 men) and a striking 46.1% of the population is aged 14 years old or younger (Hiscox, 2014). There are quite some polygamous families on Rusinga. Although there is no data on the exact number of polygamous households, it was found that 42% of the households on Rusinga consisted of more than one house (HDSS, 2013).

Today, the Luo of Rusinga Island are still predominantly a fishing community. Offshore fishing is the primary occupation of most men and adolescent boys, while the women work in the onshore business aspect of fishing, such as cleaning and drying the fish and selling the daily catch on the market. In addition, there are a lot of fishermen who are employed on short-term basis, living around the beaches and moving from island to island, following the fish which migrate around Lake Victoria. Although most permanent households have at least one member involved in fishing-related activities, nowadays many families are also trying more agriculturally-based forms of income generation, both for subsistence and commercial purposes. Due to a recent 'lack of fish' in the lake, the fishing business is becoming less profitable and less viable as a means of sustaining a family (Balirwa et al., 2003). Hence, many are planting crops and raise a few cows, goats and chickens. However, the dependence on the rainy seasons for agricultural purposes makes income still highly seasonal on Rusinga.

Malaria on Rusinga Island

Malaria has been a longstanding problem on the island for decades. In Kenya as whole, there are an estimated 6.7 million new clinical cases and 4,000 deaths each year and it accounts for roughly 31% of outpatient consultations and 5% of hospital admissions. Especially those living in Western Kenya – where Rusinga is located – are at high risk (Centers For Disease Control And Prevention, 2014; President's Malaria Initiative, 2014). Figure 6 shows the spatial distribution of *Plasmodium falciparum* malaria in Kenya.

About 70% of the Kenyan population is at risk of malaria. The majority (17 million people) live in areas of epidemic and seasonal malaria transmission where prevalence is usually less than 5%. Around 12 million people live in endemic areas, of whom one third (~4 million people) live in areas where prevalence is estimated to be 40% or higher. The areas around Lake Victoria and the coastal regions of the country are classified as endemic areas with prevalence between 20% and 40% (President's Malaria Initiative, 2014).

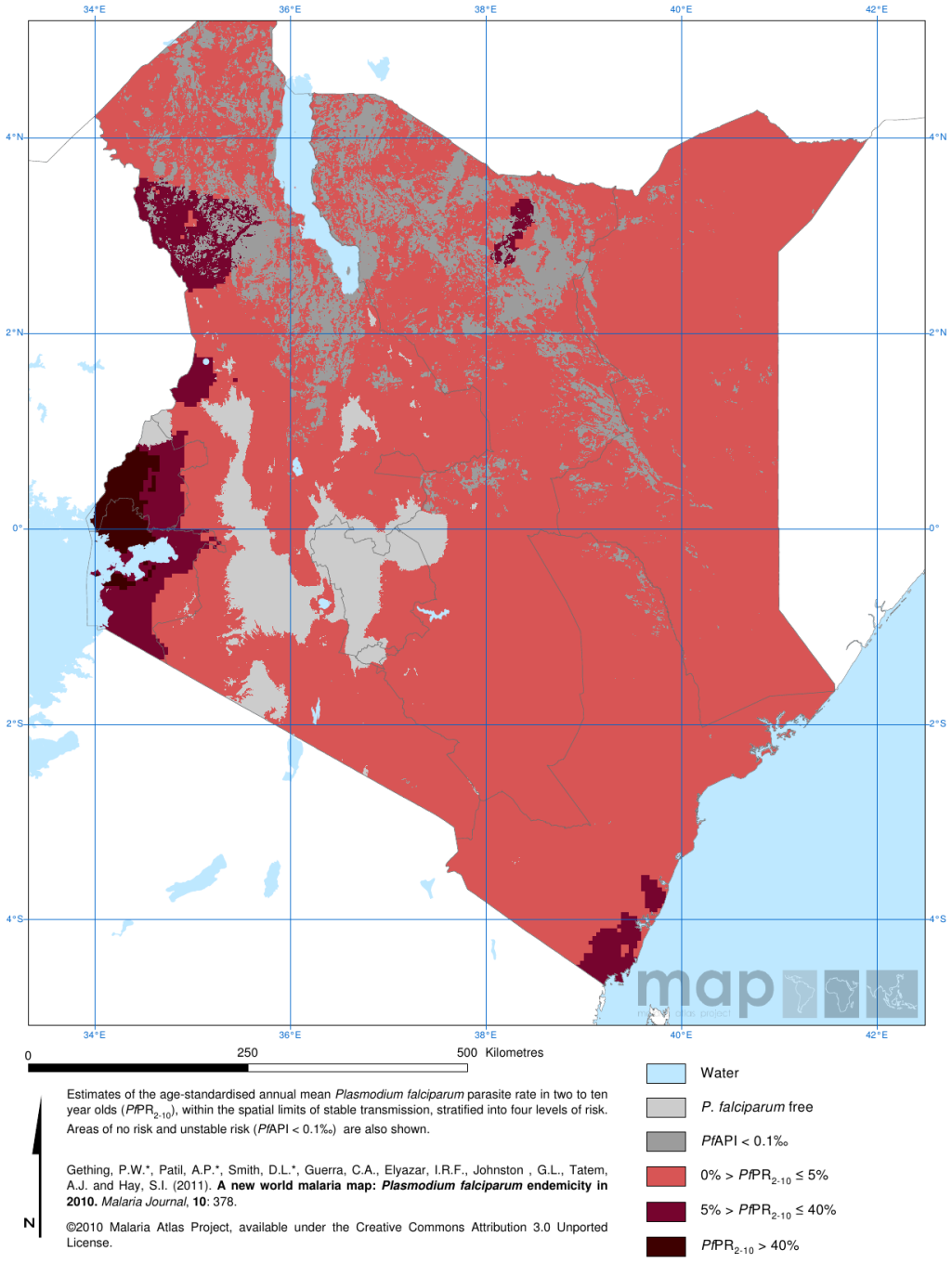

Fig. 5 - *The spatial distribution of Plasmodium falciparum malaria stratified by endemicity class in 2010 (Gething et al., 2011)*

On Rusinga, the current prevalence is 28%. The highest malaria burden is amongst children between the ages of 5 and 14 years old. Malaria prevalence per age group can been seen in figure 7.

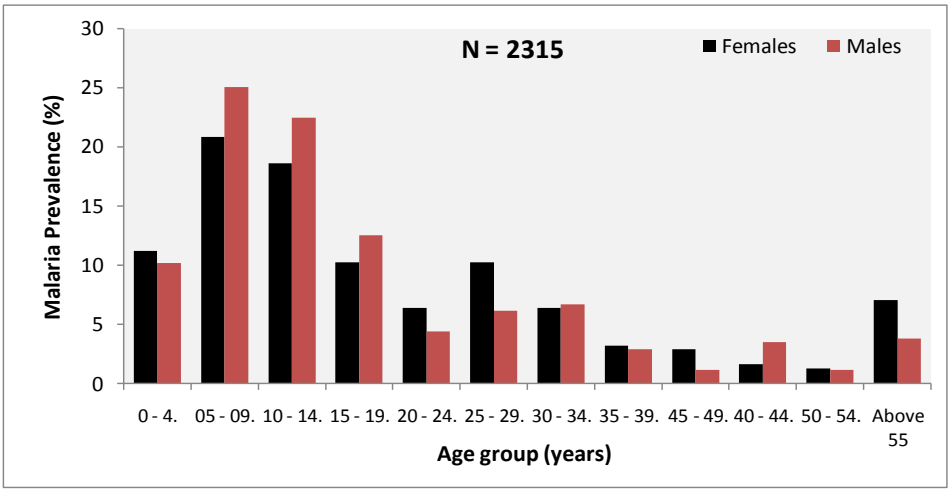

Fig. 6 – *Rapid diagnostics tests prevalence (%) among residents of Rusinga during April-May 2014 (Hiscox, Mukabana, & Takken, 2014)*

Malaria transmission and infection risk in Kenya is determined largely by altitude, rainfall patterns and temperature and the climatic conditions around Lake Victoria are favorable for mosquito viability. On Rusinga, additional construction activities, deforestation, vegetation clearance and poorly planned infrastructure increase the number of mosquito larval habitats, specifically those of *Anopheles* (Hiscox, 2014; Opiyo et al., 2007).

Community awareness

A randomly sampled household survey (n=204) conducted by the SolarMal project team on Rusinga showed that community knowledge about malaria is relatively high. The majority of those interviewed understood that malaria is transmitted through mosquito bites and almost a third recognized fever as one of the main symptoms. Most people thought that children under 5 suffer most from the disease and almost all respondents (193/204) recognized ITN usage as the main way to prevent malaria (Hiscox, 2014). During semi-structured, individual interviews (n=1,451), Opiyo et al. (2007) found that the majority of respondents thought that malaria could be controlled and would be willing to contribute to a community-based malaria control program. However, they felt they also needed outside assistance.

Other challenges

Next to malaria the community faces various other challenges. Most notably, the island has suffered extensive environmental degradation, soil erosion and drought in recent years, leaving little productive farmland. Coupled with depleting fish stocks and thus less work in the fishing business this leads to a high unemployment rate of between 25 tot 31% (Kiche, Homan, Pasquale, & Maire, 2013). Furthermore, there is a high prevalence of HIV/AIDS, around 20-22%, which causes risks for the general health of the Rusinga community (Opio, Muyonga, & Mulumba, 2013). The widespread of HIV/AIDS is associated with the young age, low education level, alcohol consumption, low condom use and high mobility of some parts of the Rusinga population (mostly fishermen who live around the beaches) and (forced) prostitution (Kiwanuka et al., 2014; Opio et al., 2013). The high prevalence of both malaria and HIV/AIDS on the island are major obstacles to socio-economic development (see Opiyo et al., 2007).

Set-up of the SolarMal project

In addition to the pressing need for solutions for malaria control, Rusinga was chosen as a research site due is its relatively isolated location which limits outside influence combined with good accessibility. Moreover, research facilities are present in the form of the ICIPE compound. The total duration of the project is four years, from 2012 to 2015. In June of 2013, the installation of 4,000 SMoTs started using a hierarchical design, meaning that they are being installed gradually over a period of two years, until 2015. The island has been divided into nine meta-clusters, each consisting of again nine clusters, making a total of 81 clusters. Each cluster contains approximately 50 households. Installation of the SMoTs started in meta-cluster one and will end in meta-cluster nine (see figure 8). As of June 6 2014, 2,116 SMoTs were installed (53% completion) with roughly 50 SMoTs being installed each week.

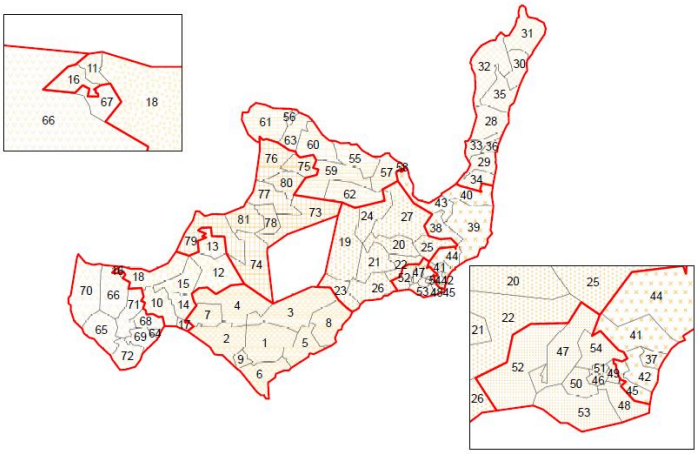

Fig. 7 – *Meta-clusters (red borders) and clusters (grey borders) on Rusinga island. Numbers indicate the order of the roll-out*

The Suna trap

The mosquito traps which are part of the SMoTs have been developed by the Laboratory of Entomology at Wageningen UR in The Netherlands and ICIPE in Kenya, and are being produced by Biogents AG in Germany. These *Suna* traps, named after the DhoLuo word for mosquito, contain nylon strips baited with a blend of five synthetic chemical attractants which is called MB5 (Mbita 5). This blend is attractive for mosquitoes, especially *Anopheles gambiae* which is the most common species at Rusinga. The *Anopheles gambiae* is even more attracted to the MB5 blend than to human odour. It is possible to adjust the blend to other mosquito species, for example *Aedes aegypti*, which transmits Dengue virus (Mukabana et al., 2012; Okumu et al., 2010).

The Suna trap consists of five main components (see figure 9); a funnel and ventilator section, carbon dioxide release pipe, perforated plastic base, netting catch bag, hanging tripod and conical plastic cover. As explained by Hiscox, Otieno, et al. (2014, p. 3) 'when the trap is connected to a 12 volt power supply the ventilator rotates, sucking air up through the funnel at a rate of 3.1 m/s, thus opening the funnel shutter gate. As air circulates under the conical cover of the trap, volatiles from a synthetic chemical blend of attractants are released from the nylon strips suspended from the hanging tripod. The odour-saturated air is forced out of the trap through holes in the plastic base at a rate of 0.5 m/s. This generates a flow of attractants, which are carried away from the trap. In addition, a plume of CO_2 diffuses from the CO_2 release pipe, mimicking breath of a host. In effect, the combination of odours and CO_2 forms a human surrogate. Mosquitoes encountering these odours fly upwind towards the trap and, when they are in close proximity to the funnel, they are sucked into the trap through the ventilator. Inside the trap they are contained in the catch bag. When the power supply is turned off, the shutter gate automatically drops to a closed position due to a weighting mechanism and mosquitoes are unable to escape. Mosquitoes caught inside the trap die due to dehydration and lack of food.'

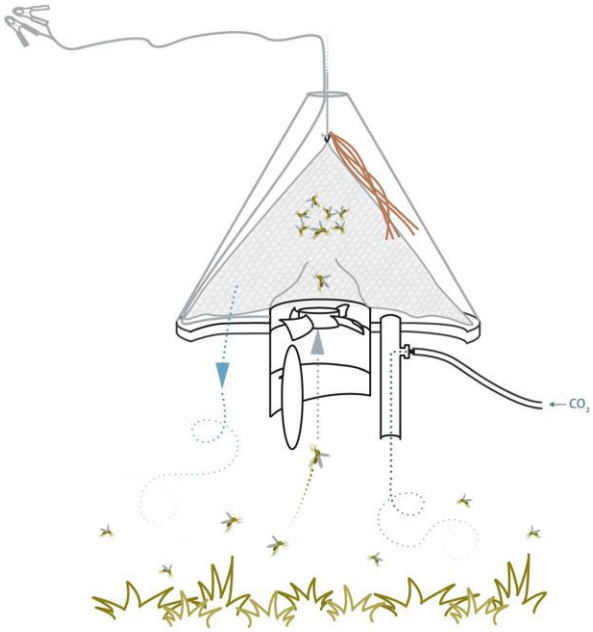

Fig. 8 – *Cross-sectional drawing of the Suna trap* (Hiscox, Otieno, et al., 2014)

The trap needs to be placed outside next to the house at ideally 30 centimeters above the ground. Tests have shown that in this way they trap reduces mosquito house entry by 32.2% (Hiscox, Otieno, et al., 2014). Odour baits need to be replaced every three months. Important to note is that people are still being encouraged to use their ITNs so that people receive the maximum amount of protection until it is proven that the Suna traps can control malaria.

Solar Powered Mosquito Trapping System (SMoT)

As the trap needs electricity to work an inclusive Solar Powered Mosquito Trapping System or SMoT has been designed together with Siempre Verde (Netherlands) consisting of one 20W solar panel, a 12V/12Ah battery, a USB phone charger and two 3W LED light bulbs. Thus, in addition to the primary aim of malaria control, the SolarMal project provides improved lightning conditions and facilitates easier mobile phone use. The SMoT is being regulated by a solar charge controller which manages the charging current for the battery and ensures that the ventilator only spins in the evening and at night when mosquitoes are active. See figures 10 & 11 for detailed overviews of the SMoT.

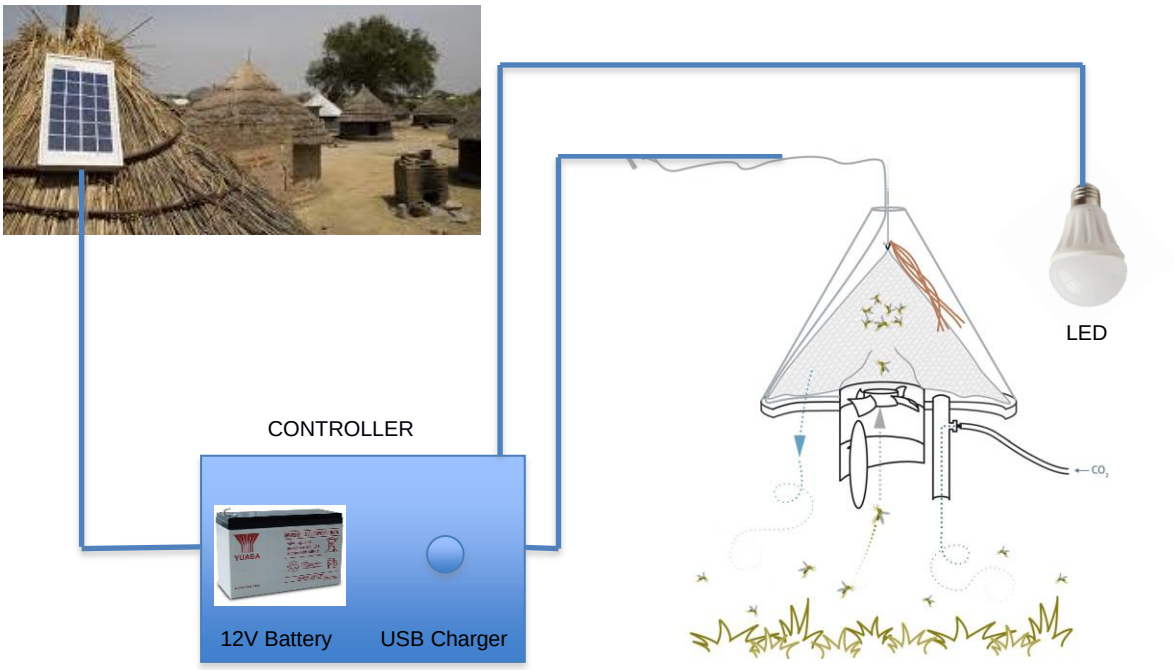

Fig. 9 – *Schematic overview of the SMoT*

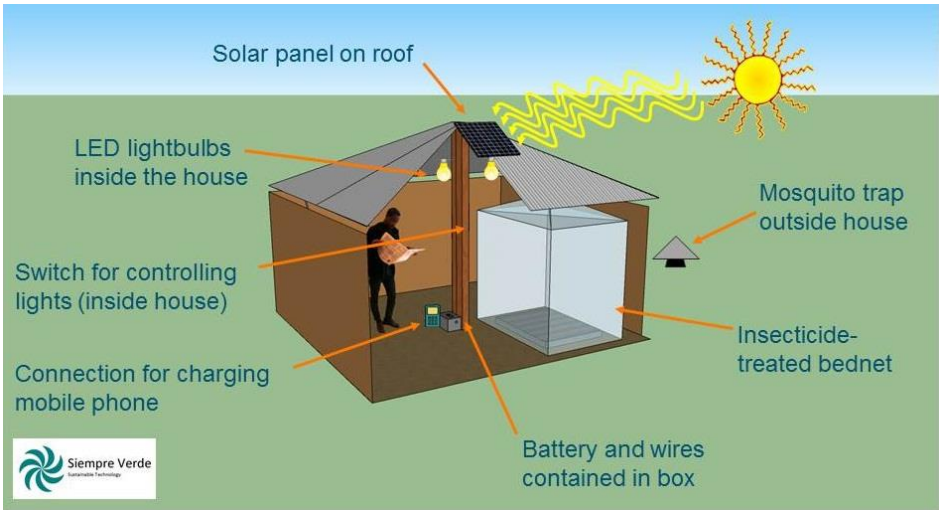

Fig. 10 – *Drawing of a house with a SMoT installed*

The total cost of one SMoT as of February 2014 is €157.90, excluding tax and shipping costs, with the most expensive parts being the trap (€70), the battery (€29), the solar panel (€22.50) and the controller (€11.60). The SMoT has been designed in such a way that it is easy to install and maintain. For example, it is possible to replace the battery after five years with any 12V battery. Moreover, the materials have been chosen in so that they can be replaced with parts that are available locally. See appendix I for a detailed overview of the total costs of one SMoT.

Community experience with the SMoT so far

The SolarMal project has been developed using a bottom up approach, placing strong emphasis on community participation (Oria et al., in press). The involvement and active participations of communities has been identified as a key factor for success in community-based disease control programs. It is vital to create a true partnership between the community and project staff and to foster elements as feeling of empowerment, local ownership and responsibility (Opiyo et al., 2007). To ensure this and to facilitate clear communication between the community and the project, a Community Advisory Board (CAB) has been formed which consists of sixteen members chosen by the people. Since the start of the project until June 2014, 43 community training workshops, 850 listening surveys in individual households, fifteen meetings with landlords, two stakeholder meetings with fishermen and three scientific workshops have been carried out. The community workshops have been attended by representatives of 1,869 households of an expected 2.312 which shows the involvement and interest of the community (Hiscox, 2014; Hiscox, Otieno, et al., 2014).

During semi-structured interviews and observational studies the experience of the Rusinga community with the SMoT so far have been analyzed. The major 'likes' were: not needing to buy kerosene, being able to go to bed later, children being able to study in the evening, charging mobile phones for free and no longer hearing the sounds of mosquitoes in the house. Although most people did not report any 'dislikes', some mentioned system malfunctions, the brightness of the LED light bulbs, the light on the USB charger and children catching malaria despite the presence of the SMoT (Hiscox, 2014). Up until June 2014, 314 malfunctions had been reported by owners of a SMoT. Most common malfunctions were faulty USB sockets (25.7%), system turning off before sunrise (21.4%) and faulty light switches (16.9%). Other complaints heard were: cables cut by animals or possible (but not proven) malice, unplugged trap cables and low voltage batteries (Hiscox, 2014).

Results of the SolarMal project so far

Preliminary findings from the field comparing the mean *Anopheles* catch sizes from areas with the intervention for almost a year with areas which have not yet received the intervention, show some indication that increases in *Anopheles* population density following the rains are lower in areas with the intervention. Although this is exciting news, the results are still very preliminary. Whether or not the intervention is successful will be known at the end of 2015 (Hiscox, 2014).

4. Methodology

This study used a mixed method approach which included focus group discussions (FGDs), a household survey (n = 100) and in-depth interviews. Hence, both qualitative and quantitative data were collected and analyzed.

Focus group discussions

At the beginning of the field research, five FGDs were held representing five different population groups living on Rusinga:

1. Women (n=9)
2. Men (n=8)
3. Fishermen (n=8)
4. Youths (aged between 18 and 26 years, n=8)
5. Opinion leaders (n=8)

The aim of the FGDs was primarily to provide in-depth opinions and perceptions of the general savings culture on Rusinga, the workings of the SMoT and to establish base prices for the willingness to pay questions in the household survey. The outcomes of the FGDs were used to update and finalize the household survey. The rationale behind inviting different groups of people was based on the assumption that opinions and perceptions are different depending on individual characteristics such as age, gender and occupation (Kumar, 1987). Except for the opinion leaders, participants were selected arbitrarily with the only criteria being (1) owner of a SMoT and (2) over 18 years old. Each participant received 200 Kenyan shilling compensation if he or she completed the discussion. FDGs were primarily held in Dho Lhuo language. Every discussion was facilitated by one Kenyan member of the SolarMal project team, assisted by one Kenyan note taker and myself. Before the start of the FDGs, a meeting was arranged in which the facilitators and note-takers were instructed so that they knew how to facilitate the discussion without probing, understood what kind of information was desired and were aware of the essential key points in wording. During the FGDs, respondents were asked to speak freely and frankly and it was stressed that no answers were wrong, in order to create good group dynamics and mitigate social desirability bias (Kumar, 1987). All FDGs were held at the same location, the Sienga church at the Western part of Rusinga in April 2014. See appendices II and III for the FGDs questions and pictures.

Household survey

A household survey was conducted in 100 households, each owning a SMoT and living in meta-cluster 1, 2 or 3 of the rollout. The aim of the survey was to collect data on how people perceive the SMOT, peoples' willingness to pay, existing access to saving options and saving behavior. Initially, households were sampled randomly per cluster from the database of the SolarMal Health and Demographic Surveillance System (HDSS). Each survey day, two Kenyan members of the project team and myself went into the field, visiting around ten households a day. As the survey progressed, it became clear that youths were difficult to reach as they were often not present during the daytime. As a result, I had to abandon the randomly sampled household list and approach some youths directly in the field. Hence, it is important to point out that the sample is not completely representative for the Rusinga population. While a few interviews were conducted in English, the vast majority was done in Lhuo. Interviews were processed using the open source program Open Data Kit (ODK) on a Samsung Galaxy tablet. Each interview consisted of a maximum of 50 questions and the average duration was 30 minutes. The interviews took place inside or outside the houses of the respondents. Before the start of the survey, a pilot test was done in the field to review whether the questions asked were comprehensible and clear. See appendix IV for the survey interview questions. The survey data was analyzed using the statistical computer program SPSS.

Willingness to pay: the Contingent Valuation Method

During the survey, the Contingent Valuation Method (CVM) was used be used to elicit willingness to pay (WTP) (Alberini & Cooper, 2000). Contingent valuation has its roots in resource economics and is a survey method for eliciting market valuation of a non-market good. For market goods, price measures the WTP for one more unit. When there is no price, or little data is available on what users will pay, CVM is commonly used. The approach creates a hypothetical marketplace by asking people directly to report the maximum amount they are willing to pay for a certain good.

As elicitation technique I used the iterative bidding approach (Randall, Ives, & Eastman, 1974). In practise, this meant I asked the respondent if he or she would be willing to pay for maintaining the SMoT. When the respondent expressed willingness to pay some amount, I suggested the base price determined in the FDGs. I used Kenyan shillings (Ksh) as the currency. When the respondent was willing to pay this price, I continued asking a higher price, increasing the base price by 50Ksh. This process proceeded until the respondent said he or she

was unwilling or unable to pay the stated price. When the respondent indicated he or she was unable or unwilling to pay the base price to begin with, I used the same process but started with a lower price.

Although the use of the method is now widely accepted, there are some difficulties to bear in mind when using the CVM, most notably strategic behaviour, protest answers, response bias and respondents ignoring income constraints (Diamond & Hausman, 1994). For example, if the respondent is aware that the results will be used to actually price a good, he or she may say a lower price than the true value. Or if the hypothetical scenario is too complex to understand, the respondent may get annoyed answering the questions quickly without too much thought. The reason why I chose to use the CVM, despite its drawbacks, was twofold. First, in the case of the SMoT, the respondents were already familiar with the product for which they need to start paying in the future. Hence, they had experience using the product, which enabled them to judge – to a large extent – the utility gained from it. Second, the survey was not meant to support the launch of a commercial product, but to research whether people were able and willing to pay the maintenance costs of a product that was given to them for free and is likely to benefit their living quality. As such, although it remained important to gain the trust of the respondents, I expected that their stated preference was or came close to their real preference.

Asset data analysis

Following Filmer and Pritchett (2001), a principal component analysis (PCA) was used to compose a durable asset index for comparisons of wealth across households. The assets included in the analysis are: car battery, boat, bicycle, radio, television, motor cycle and generator. The Kaiser-Meyer-Olkin (KMO) test was used to ensure sampling adequacy. This test compares the magnitude of observed correlation coefficients with the magnitudes of partial correlation coefficients. The KMO index can be between 1 (= high), meaning that the PCA can act efficiently or 0 (= low), meaning that the PCA is not relevant. For a PCA to proceed, the KMO has to be 0.5 or higher (Hutcheson & Sofroniou, 1999). In this analysis, the KMO equals 0.67, indicating that the assets share enough common factor to proceed with the analysis.

In order to calculate the total amount of livestock owned expressed in monetary terms, prices of livestock were multiplied by the number of each type of livestock owned. Prices that were used were: cow (15,000KSh), donkey (9,000Ksh), goat (3,500KSh), sheep (3,000Ksh) and chicken (800Khs).

In-depth interviews with local finance professionals

Four interviews were held with three local finance professionals and one women's saving group coordinator. The purpose of these interviews was to deepen the understanding of the local saving culture by hearing the thoughts and opinions of local people working in finance. The four people interviewed were:

1. A coordinator of 35 women saving groups on Rusinga Island
2. A business development officer at Kenya Women's Finance Trust (KWFT) Mbita
3. A branch manager at Co-operative Bank (Co-op) Mbita
4. An account opening officer at Equity Bank Mbita

Each interview was held in English, the duration was on average one hour. See appendix V for the interview questions.

5. Results

This chapter contains the results, presented in the following order: (1) population and household characteristics, (2) savings attributed to the system, (4) willingness to pay, (4) the saving culture on Rusinga and access to saving options and (5) the most suitable saving option to maintain the SMoT.

Population and household characteristics

As mentioned earlier, Rusinga has a young population. In this sample (n=100 households), 31% was 28 years or younger with slightly more females (52) compared to males (48). In regard to education, 22% completed primary school only, compared to 47% who completed secondary school, while 19% completed college and 12% did not complete any grade (figure 12).

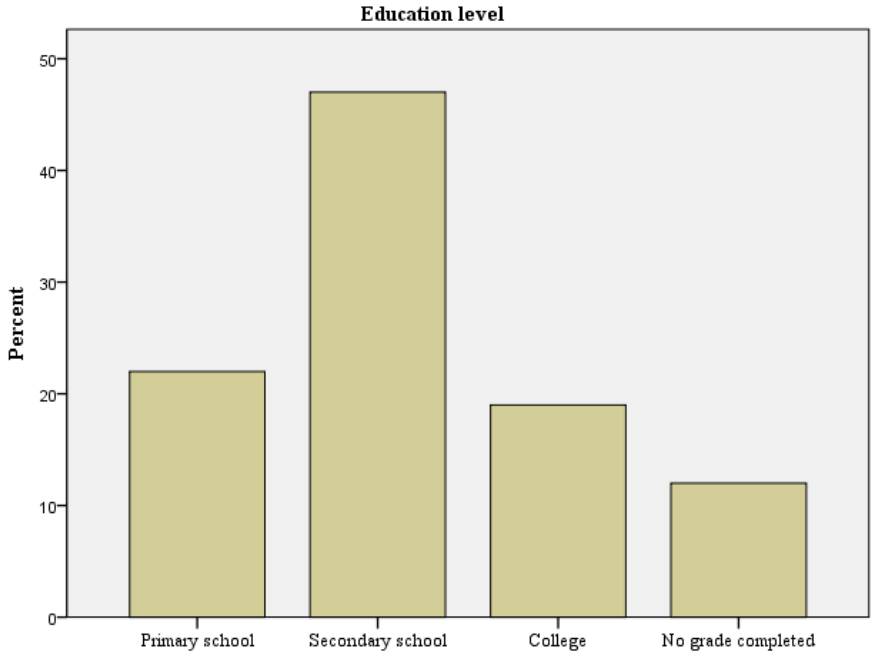

Fig. 11 - *Education level of sample (%)*

There existed considerable unemployment; in this sample 31% of the interviewees did not have a job (defined as an activity which generates income) (table 1). In comparison, during the baseline study 25% of the respondents was unemployed (HDSS, 2013). Most people were primarily active in the fishing business. Among those who had a job, 48% either fished, sold fish or owned a fishing boat. The second most common primary job was being a teacher and the third being a farmer. Among the 69 people who had a job, 29% also had a secondary job.

Farming was most commonly reported, followed by fishing. When asked if the spouse of the participant had a job, a similar pattern became visible. Among the spouses who had a job (n=45), most were active in either fishing or the selling of fish (60%). The second most common primary job of spouses was also farming. Among the 45 spouses with a job, 27% also had a secondary job. Farming and fishing were both equally important.

	Are you employed? (%)	Do you have a secondary job? (%)	Is your spouse employed? (%)	Does your spouse has a secondary job? (%)
Yes	69 (69)	20 (29)	45 (57)	12 (27)
No	31 (31)	49 (71)	34 (43)	33 (73)
Total	100	69	79	45

Tab. 1 – *Employment rate of sample*

On average, each household consisted of 5,75 members (s=2,86) while the smallest household consisted of one person and the largest household consisted of 17 people. In 80% of the cases, households owned the house they lived in, whereas 16% rented the house and 4% used the house without paying rent and without being the owner. Respondents who rented their house were all but one active in fishing. A large number of households (86%) owned farmland while 19% owned fishing equipment. Of the households owning farmland, 75.6% owned 1 acre of land or less.

Most households (77%) owned livestock, with a mean of 13 animals per household and a minimum of 1 animal and a maximum of 43 animals (s=9,75). In monetary terms, the minimum amount of money a household owned in the form of livestock was 800Ksh and the maximum 321,900Ksh, with a mean of 66,849KSh (s=66,020) (table 2).

	Minimum	Maximum	Mean	Std. Deviation
Total amount (Ksh)	800	321900	66849	66020
Total amount (Euro)	8	3188	662	654

Tab. 2 - *Livestock total sum*

Using principal component analysis a weighted asset index was constructed, after which all households received a specific asset index score. Subsequently, households were divided in four most equal groups (table 3). The poorest group consisted of all households who owned the

lowest value in assets, whereas the richest group consisted of households who owned the highest value in assets. This distinction made it possible to create the variable *household wealth* which could be used in further analysis.

Groups	Households
Poorest group	23
Second group	30
Third group	26
Richest group	21
Total	100

Tab. 3 – *Four groups based on the asset index scores*

Conclusion

The Rusinga community is female biased and young in age. Although the Rusinga population is relatively educated, its general education level is below the national average. The current schooling system in Kenya is designed to provide eight years of primary education, four years of secondary education and four years of college or university education. In Kenya as a whole, the expected years of schooling in was 11,7 years in 2013 (UN Development Programme, 2013). In this sample, 12% did not complete any grade while 22% only completed primary school, hence 34% received 8 years of schooling or less. Many people were unemployed; an unemployment rate of 31% was found, compared to 25% in the baseline study. Most respondents who had a job were active in the fishing business (48%), while farming was important as a secondary job. This finding confirms that fishing is indeed the most important economic activity on Rusinga.

Households on Rusinga are relatively large; they consisted on average of 5,75 members per household which is 1,35 higher than the average national household size of 4,4 members per household (Government of Kenya, 2013). Almost all respondents who did not own their house, were active in the fishing business. This corresponds to the fact that most households that are active in the fishing business live around the beaches were they rent housing. Many households (86%) own farmland on Rusinga, although most households (75,6%) owned farmland of 1 acre or less. This implies that farming is still mostly a subsistence activity, even though there are households who are starting to farm commercially as a reaction on the depleting fish stocks. Many households (77%) own livestock, with a mean of 13 animals per household (in monetary value 66849Ksh or €662,-).

Perception of the SMoT

FGDs

During the FGDs, both the LEDs and the trap were mentioned as the most important services of the SMoT. The general consensus was that the trap works and that it reduces mosquito bites and malaria. In regard to the LEDs, the most frequently heard comments were that the lightning makes it possible for children to study at night and that households save money on buying kerosene. However, the youths, men and opinion leaders all complained that the light attracted mosquitoes. Women also explained that members from polygamous households who did not receive the SMoT complained that they are bitten even more. Across all FGDs, participants said that the SMoTs and the traps in particular are mostly maintained by women and in both the FGDs with men and women the remark was made that women are more concerned with the SMoTs in general. All participants were aware of the fact that they would become the owner of the SMoTs in 2016 and said they were willing to maintain the trap in future.

Survey

When respondents were asked which service of the SMoT they found most important, a striking 81% answered they found light the most important service compared to 17% who found the trap most important. Moreover, only 23% mentioned the trap as second most important service while 24% did not mention the trap at all. In regard to the mobile phone charger, only 2% found this the most important service but 53% found it the second most important service. Males and females were almost equally represented among the three services of the SMoT (table 4).

		Gender		
		Male	Female	Total
Most important service	Light (%)	39 (48)	42 (52)	81
	Trap (%)	8 (47)	9 (53)	17
	Mobile phone charger (%)	1 (50)	1 (50)	2
Total		48	52	100

Tab 4. – *Cross tabulation of most important service versus gender*

The two main reasons why people found the light most important were because (1) they saved money on buying kerosene and (2) it allowed them to illuminate their home so they can perform tasks in and around the house at night. For a thorough study on the effects of the LEDs on household dynamics see Okoth (2014). The mobile phone charger is also regarded as important

because people save money on charging their phones at charging shops. Respondents who did mention the trap as an important service said it reduces mosquitoes in their home, it reduces mosquito bites and one person argued it reduces malaria. When asked which disease bothered them most, 87% mentioned malaria first, which shows the burden of malaria on Rusinga. The second most prominent disease was typhoid (25%).

Even though few respondents mentioned the trap as an important service of the SMoT, 76% said they received less mosquito bites since they own the SMoT and 87% said they experienced less malaria. When asked if they could remember how many malaria episodes their household experienced over a three month time-span *before* the instalment of the trap, 97 respondents could and 85.6% said their household experienced on average three episodes or less per month. When asked if they could remember how many malaria episodes their household experienced over a three month time-span *after* the instalment of the trap, 95 respondents could and 82,1% said their household experienced on average one episode or less per month. Most respondents (88%) saw the trap as a preventive health measure. After each interview the condition of the trap was checked. Roughly half of the traps (55%) were in fair condition, meaning that they were dusty but not too much to prevent operation, being protected by a reasonable strong fence and that the catch bag was reasonably emptied from mosquitoes. A little more than a third of the traps (33%) were in good condition meaning they were clean, the catch bag was empty and it was protected by a strong fence. The rest of the traps (12%) were in bad condition, thus dusty, not emptied from mosquitoes and not protected by a fence.

Conclusion

Following the theory on preventive health investments, households need to believe that the risk of bad health shocks would be reduced through the preventive technology before investing in it. For the SMoT, this means that households need to be convinced that the Suna trap reduces malaria to such an extent that they are willing to pay for it. The results show that people are willing to maintain their SMoT, or at least part of it. Especially the LEDs, and to a lesser extent the mobile phone charger, are regarded as important as both components seem to increase the quality of life in a very clear, direct way. The lighting allows people to illuminate their homes and perform tasks in and around the house during night time. The mobile phone charger improves communication as people can easily charge their phones. Moreover, both components save people money on buying kerosene and charging their phones at phone charging shops.

The importance of the trap is more difficult to determine. First, although most survey respondents said they experienced less mosquito bites and less malaria since the used the trap and said they saw it as a preventive health measure that decreases malaria, a quarter of the sample did not mention the trap as an important service of the SMoT at all, when they were asked to answer the open ended question 'What do you find the most important service of the SMoT?'. Second, quite a few traps were in fair (55%) to bad (12%) condition. Possible explanations for these results will be discussed later in the discussion. Important to note is that the reported decrease in malaria episodes may not have be caused by the trap but through weather fluctuations. The survey was held during the dry period in which there is less mosquito activity and thus less malaria. It could also be there may not be a decrease at all, only a perception of one amongst the houses I visited. In addition, data on self-reported malaria episodes is prone to noise so before one can draw any conclusions on the decrease of malaria, clinical data from local health facilities and SolarMal led cross-sectional surveys is necessary.

Savings attributed to the system

FGDs

During the FDGs, each group gave very different estimations regarding the amount of money they saved using the SMoT. The opinion leaders estimated they saved 1750Ksh per month, whereas men estimated they saved 1000Ksh and women thought they were saving 500Ksh per month.

Survey

In the survey, I broke the question down. Firstly, I asked how much the respondent estimated he or she saved on kerosene using the LEDs. Most households (29%) saved 400Ksh or more per month and only 5% saved less than 100Ksh per month (figure 13).

Secondly, I asked how much the respondent thought he or she saved on charging their phone using the mobile phone charger. The most common response (36%) was 'saving less than 100Ksh per month' but still 18% saved 400Ksh or more per month (figure 14). Interestingly, 10% did not use the mobile phone charger; 5% did not own a mobile phone while the other 5% did not have a USB-compatible port on their phone.

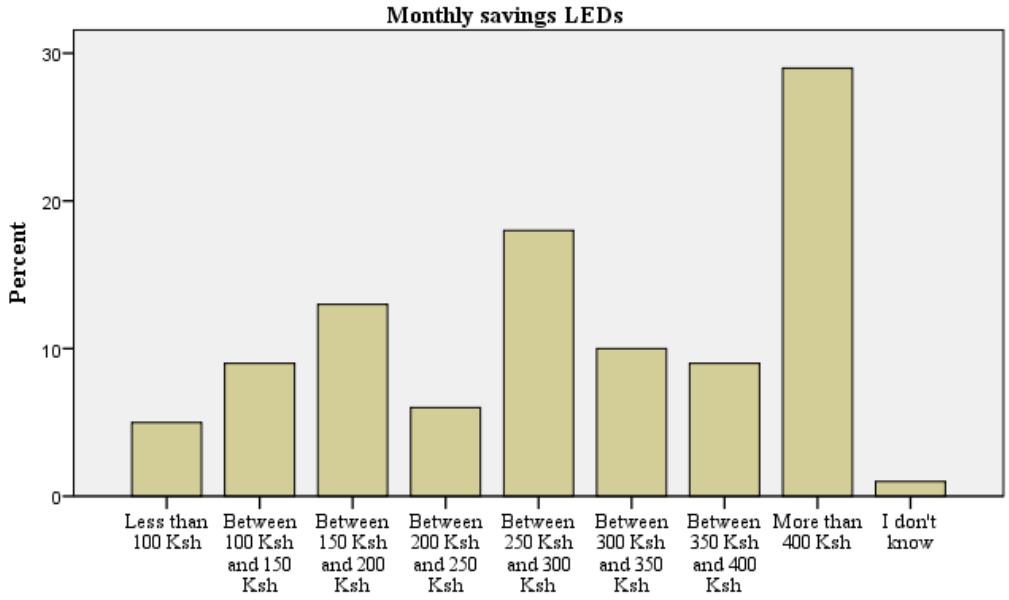

Fig. 12 – *Monetary savings attributed to the use of the LEDs per month (%)*

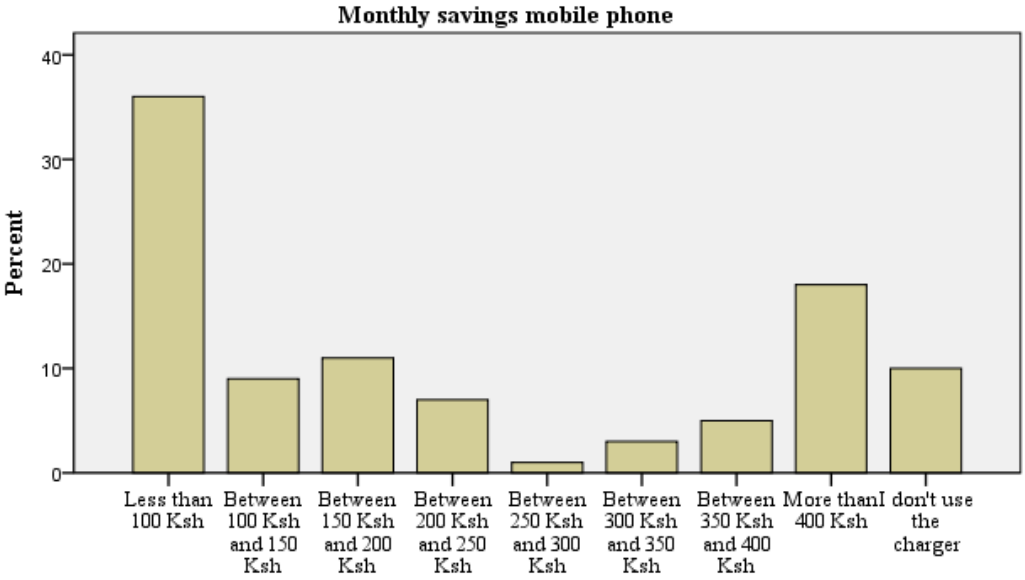

Fig. 13 - *Monetary savings attributed to the use of the mobile phone charger per month (%)*

Because I could not directly ask how much money people saved using the trap as this would be difficult to answer, I asked respondents how much they spent on average on malaria treatment when they suspected that a household member suffers from malaria. The costs were divided in to transport, check at the health clinic, malaria drugs and other costs. On average, households spent 315Ksh per malaria case, with a minimum of 0 and a maximum of 2900Ksh (s=323,3) (table 5). Malaria drugs form the bulk of expenditure, followed by the check at the health clinic.

	Minimum	Maximum	Mean	Std. Deviation
Treatment costs (Ksh)	0	2900	315	323.349
Treatment costs (Euro)	0	30,10	3,30	3,36

Tab. 5 – *Malaria treatment costs*

I also asked if the household lost any labour or schooldays during a malaria infection in the last three months and if so, how many. Of the total sample, 49% said they lost labour or school days while 42% said they did not and 9% said they did not know. Each household that said it had lost labour or school day, lost on average 8,35 days with a minimum of 1 and a maximum of 28 (s=5,85) in total over the last three months.

Conclusion

During the FDGs the estimations on what households saved using the SMoT were considerable but varied wildly per group. This could have been caused by social desirability bias; some participants may have been afraid to truly state the amount of money they saved, ultimately naming an amount that was fairly lower than the real amount. Maybe they thought the outcome of the FGD would be used to price the SMoT, despite our explanation it would not, or maybe they did not want to disclose the amount they saved in front of others. This assumption is strengthened by the fact that women gave a particularly low estimate, while a SolarMal project staff member told me beforehand that women would be most hesitant in providing information on financial matters (she could not really explain why). From all groups, women were indeed the ones who were most reluctant in talking about how much they saved using the system.

During the survey, I had the opportunity to break the question down and ask the respondents individually. This time, most respondents expressed they saved substantial amounts of money using the LEDs and the mobile phone charger. It was not possible to directly ask respondents how much they saved using the trap, so instead I asked how much they spent per malaria case which was on average 315Ksh. Considering that most households reported they experienced on average three malaria episodes or less per month *before* using the trap, and one or less episode per month *after* using the trap, and assuming this can be attributed to the trap, households can save considerably amounts of money using the trap via reduced expenses on malaria-associated preventative and treatment costs and reduced lost labour/school days. Especially for households with children below the age of 14 who are vulnerable to malaria, savings on treatment costs can be considerable and in some cases even higher than the

savings from the LEDs. Calculating how much households save on lost labour and school days is beyond the scope of this research but it is likely a significant amount (to read more on the economic costs of malaria see Chuma, Okungu, & Molyneux, 2010; Lucas, 2005; Malany, Spielman, & Sachs, 2004; Sachs & Malaney, 2002). It is important to point out that, although households can save money using the trap, I got the impression that, both during the FGDs, and during informal talks while conducting the survey, respondents were not (fully) aware of the possible financial benefits of using the trap. I will come back to this issue in the discussion.

Willingness to pay

FGDs

During the FGDs participants expressed they were willing to pay in order to maintain their SMoT. On average, people were willing to pay 200Ksh maintenance costs per month. When I asked why they only wanted to pay on average 200Ksh to maintain the system if they saved significantly more using it, the participants explained they used the money for other important things such as school fees, transportation, and general daily expenses. Some participants were also frank in saying they used it for leisure activities. The 200Ksh was used as base price during the survey.

Survey

In the field it soon became clear that every interviewee except one was willing to pay 200Ksh. However, once the price was raised to 250Ksh, each respondent answered that this was the highest price they were willing to pay. This process continued for 50 interviews until I started to suspect that people did not express their true willingness to pay by observing how they reacted on raising the base price. Hence, I decided to benchmark the base price and raised it to 300Ksh for the next ten interviews. Again, the same pattern occurred. People were willing to pay 300Ksh, but not 350Ksh. I decided to raise the base price again for the next ten interviews to 400Ksh and the pattern repeated. Ultimately, I raised the base price to 800Ksh during the last ten interviews. At this price, some interviewees answered they did not want to or could not pay the base price.

In the end, two persons were not willing to pay 200Ksh. They were willing to pay 50Ksh and 100Ksh respectively. The rest of the interviewees were willing to pay 200Ksh or more. On average, people were willing to pay 424Ksh per month with a maximum of 1500Ksh (s=274). Interestingly, 9 out of 12 households who said they were willing to pay between 800Ksh and

1500Ksh per month, were not saving. I also asked what households were willing to pay to maintain both the solar panel and the trap only. In this case, respondents were willing to pay on average 164Ksh with a minimum of 20Ksh and a maximum of 500Ksh (s=106).

Conclusion

This study only partly succeeded in establishing peoples' WTP to maintain the SMoT. In retrospect, it can be concluded that the base price that came forward from the FDGs was not correct and should have been higher. Although it was explained to the FGD participants that their answers would not be used to price the SMoT, people may have thought it would be better to state a price that was lower than their actual willingness to pay. My assumption that their stated willingness to pay would be close to their actual willingness to pay was proven wrong and due to the benchmarking of the base price, it was impossible to use the data for regression analysis. It made it also impossible to further analyse whether households with children were willing to pay more to maintain the trap than households without children or whether female household heads were willing to pay more for maintenance than male household heads. Still, this WTP analysis does provide direction for subsequent analysis in choosing a correct base price. In this study, an average WTP of 424Ksh per month to maintain the SMoT was found, but I expect the WTP be around 800Ksh per month, as it was at this base price that households increasingly said they did not want or could pay this sum per month. The same accounts for households' WTP for maintain the solar panel and the trap only, where the average WTP was 164Ksh. Further research is necessary to gain a better understanding of the actual amount people are willing to pay for the SMoT as a whole and the trap specifically. Important to note is that subsequent research should try to make a clear distinction between willingness and ability to pay (ATP), as the finding that 9 out of 12 households who are willing to pay between 800Ksh and 1500Ksh do not save, hints to the fact that the WTP of (some) households to maintain their SMoT is higher than their actual ATP. I will come back to this issue in the discussion.

The saving culture on Rusinga and access to saving options

Interviews finance professionals

The interviews with the financial professionals offered a historical view on the saving culture on Rusinga. In February 2008, Co-operative Bank was the first bank to open a branch in Mbita, followed by Equity Bank and in 2013, KCB also opened a branch. Before 2008, there were only microfinance institutions (MFI) active in the area. At that time, the fishing industry was still booming and not many people were thinking of saving money, simply because they did not have

to. Especially fishermen spent their money easily on leisure activities that included (unprotected) sex with women and drinking which increased the spread of HIV/AIDS (Co-op branch manager, 2014). When Co-operative first opened a branch in Mbita they were not welcomed, as some MFIs had previously misused peoples' savings; collecting money and then disappearing. However, once the population understood the bank was part of a national, legitimate company, people started slowly to open accounts. Especially the higher middle class (teachers, civil servants etc.) and the business class (fishing boat owners and shopkeepers) started saving at banks. Today, primarily men save through banks, although the number of women is increasing. Men are generally more approached by banks than women, making it easier for them to walk into a bank to make enquiries and do transactions. For women, banks can be intimidating (Co-op branch manager, 2014; women's group coordinator, 2014). For example, when Co-operative Bank opened their branch in Mbita, some women did not dare to enter the bank because they did not want to make the tiles dirty. The manager had to step outside and ask them to come in. Fishermen are the group that is least saving at banks, although throughout the years several organizations have tried to reach them. The Co-operative Bank, for example, worked together with the NGO Africa Now in a comprehensive program to teach fishermen about finance and saving while trying to improve their market access. During the program, fishermen could borrow money in groups via the beach management units. However, this appeared to be very difficult as a lot of fishermen migrate and lack collateral. In the end the project failed (Co-op branch manager, 2014).

Although people have started banking, all of the finance professionals who were interviewed found that the current saving culture in Mbita and on Rusinga was still underdeveloped. They estimated that in the Mbita region, between 15 to 30% of the households is saving (Co-op branch manager, 2014; Equity account opening officer, 2014; KWFT business development officer, 2014; women's group coordinator, 2014). According to the Co-op branch manager (2014), in Kenya as whole, many people are still unbanked. Banks see this as an opportunity and are now opening branches in remote or even hostile areas in Kenya such as the Somaliland border area. In Mbita, a fourth bank, the Postbank opened a branch in 2014 and Kenya Women's Finance Trust, K-REP Bank and SMEP are all planning to open branches in Mbita in the coming two years. This means that in a two year timespan, six banks will be active in the Mbita region (KWFT business development officer, 2014).

The finance professionals argued that people have relatively easy access to various saving options such as banks, M-Pesa/M-Shwari (mobile banking) or group saving. For example, the women's group coordinator (2014) coordinates 35 women's saving groups, each consisting of 5 to 30 people; a total of 300 women. The fact that many people do not save is mainly due to a lack of income, financial illiteracy and self-control problems. In regard to banks, low-interest rates are a problem, as well as the distance people have to travel to deposit and withdraw money and the related charging fees. Moreover, the Lhuo culture was characterized as being a 'low saving culture'. This has his origin in history as Lhuo's living around Lake Victoria were used to earning money easily through fishing. Secondly, the focus in the Lhuo culture has always been on the collective; they have large families and help each other out financially. Investment and saving often seem to come on second place. On a side note, it was reported that the opening of many new bank branches has increased competition. As a result, banks try to sell people different kinds of financial products such as a car loans, mortgages, or personal loans. Some people struggle to repay these loans which deprives savings (Co-op branch manager, 2014).

In order to overcome these challenges, it was suggested to educate people on the benefits of saving and in addition use role models to encourage people to save. Furthermore, it is important to bring banks closer to people by opening little shops on Rusinga and by developing online and mobile banking. Three of the four professionals ended by saying that even though it can take a while, more and more people will start using banks for their savings and general financial transactions and that the saving culture in the Mbita region is improving. The financial environment of Mbita and Rusinga is changing as financial institutions are opening their doors and NGO and government programs are being initiated to spur financial literacy (Co-op branch manager, 2014; Equity account opening officer, 2014; KWFT business development officer, 2014).

FGDs

During the FGDs, participants expressed that they thought between 50 to 75% of the people living on Rusinga were saving. Formally employed people such as business people and teachers were pointed out as individuals who do, but also specifically women. Interestingly, in each FGD, except the FGD with men, it was said that women are the ones who primarily save. Both youth and fishermen were classified as groups whom do not really save. Each group said they have enough options to save such as banks, M-Pesa/M-Shwari, saving groups, merry-go-

rounds and by investing in livestock. People are saving for a wide array of things such as school fees, emergency issues, to buy household items, to finance their wedding, to invest in businesses and for general financial security.

Participants explained they found it difficult to save in general, mostly because the money they earn goes from 'hand-to-mouth', meaning they use it for buying food and other basic necessities and do not earn enough income to save money as well. Other problems that were mentioned were poor interest rates, inconsistent income, high bank charges, financial illiteracy, dishonesty in group saving, an unstable political environment, a poor economy and general laziness. Youth and fishermen preferred saving through M-Pesa/M-Shwari, whereas men and opinion leaders preferred saving at the bank and women were more into group saving. When asked what they needed to overcome these challenges, participants mentioned having a higher and constant income, bringing the banks closer to people, receiving financial education and using role models to motivate those who are having trouble saving. In the FGD with men it was mentioned that 'people needed to start embrace saving instead of spending a lot of money on leisure activities'. According to the opinion leaders, many people fail to 'prioritize investments' and especially youths do not have a saving strategy. In regard to the most suitable saving option for Rusinga as whole, three groups (women, men and youth) named saving through banks. The opinion leaders thought group saving would be the best option whereas the fishermen choose M-Pesa/M-Shwari.

Survey

During the survey, 56% of the households said they were saving. This corresponds roughly to what was said during the FGDs but is considerably higher than what the finance professionals estimated. The wealthiest households were saving more – in number – compared to the poorest households (table 6).

		Are you saving?		
		Yes	No	Total
Household wealth	Poorest group (%)	11 (48)	12 (52)	23
	Second group (%)	19 (63)	11 (37)	30
	Third group (%)	11 (42)	15 (58)	26
	Richest group (%)	15 (71)	6 (29)	21
Total		56	44	100

Tab. 6 – *Cross tabulation of household wealth versus are you saving?*

When asked who in the household saved primarily, slightly more men said they were saving primarily. Furthermore, more females said their spouse, partners or parents saved primarily compared to men (table 7).

		Who in the household saves primarily?		
		Me	My spouse, partner, parents	Total
Gender	Male (%)	21 (78)	6 (22)	27
	Female (%)	19 (65)	10 (35)	29
Total		40	16	16

Tab. 7 – *Cross tabulation of gender versus who in the household saves primarily?*

From these figures, it seems that there are slightly more men saving compared to women. This is a different finding compared to the findings from the FGDs and the interviews where the general thought was that women are the ones who primarily save.

In regard to age, especially respondents in the age brackets 29-39 years and 40-50 years saved. Of the respondents older than 62 years, 72% was not saving. More than half (55%) of the youths (18-28 years) is not saving, which seems in line with the findings from the FGDs (table 8).

		Age					
		18-28 years (%)	29-39 years (%)	40-50 years (%)	51-61 years (%)	62+ years (%)	Total
Saving	Yes	14 (45)	19 (79)	14 (66)	5 (50)	4 (28)	56
	No	17 (55)	5 (21)	7 (34)	5 (50)	10 (72)	44
Total		31	24	21	10	14	100

Tab. 8 – *Cross tabulation of saving versus age*

During the FGDs and the interviews it was mentioned that people active in the fishing business do not really save. From the survey, it was found that of the 33 respondents whose primary job was fishing related, 11 people (33%) were not saving. The same figure applied for respondents who's primary job was farming (1 out of 3 did not save, thus 33%) while 16% of respondents who's primary job was teaching were not saving (1 out of 6).

The most common reasons for people not to save was lack of income and being unemployed (77.2%). Other reasons were the obligation to pay school fees, other financial commitments, being a student, and one respondent never thought of it. Of the 56 people who did save, 59% said they found it difficult. Again, lack of income was the most important reason (48%) followed by having to pay for school fees (18%) and family members that were financially dependent (12%).

Of the people who saved, 40% was primarily using a bank account and 34% was primarily using M-Pesa/M-Shwari. Groups saving in the form of table banking or merry-go-round was the third most important saving option (18%). The rest of the respondents saved by storing cash at home (5,5%) or by investing in livestock (2,5%). Men saved primarily at the bank whereas women saved primarily through group saving. Fishermen and youth indeed saved mostly through M-Pesa/M-Shwari. For each of the three main saving options, the respondents named three main advantages and three main disadvantages. Table 9 shows an overview of most frequently heard advantages and disadvantages of the three main saving options in random order.

Saving product	Advantage	Disadvantage
Banking	• Safest place to store money • Interest • The possibility to take loans • Protects you from impulsive purchases since you can put access restrictions on your savings and the bank is far away	• High service charges • Low interest rates • Bank is located far way, not easy to reach • There is a maximum amount you can withdraw • Risk of fraud
M-Pesa/M-Shwari	• Easy accessible from my phone • User charges are very low, especially in comparison with banks • Low fees make it possible to save small amounts • M-Pesa/M-Shwari agents are located close by • I can quickly withdraw money when necessary	• Network problems can make it impossible to use M-Pesa/M-Shwari

Group saving	• It is encouraging, we can share ideas • Interest • The possibility to take loans • The group meetings are close by	• Dishonesty by group members • Late repayment issues • Misuse of funds by group leaders • Time consuming

Tab. 9 – *Advantages and disadvantages of banking, M-Pesa/M-Shwari and group saving*

Interestingly, 13 respondents who saved using the bank said banking had zero disadvantages. The same in regard to mobile phone saving; 13 people who saved using M-Pesa/M-Shwari said mobile phone saving had no disadvantages. In regard to group saving, 8 people who saved in groups said it had no disadvantages.

The question 'How much do you save per month?' provided a rather surprising result: a little bit more than 30% of the people who saved, saved more than 2000Ksh per month, while 12.5% was saving between 1500 and 2000Ksh a month (figure 15).

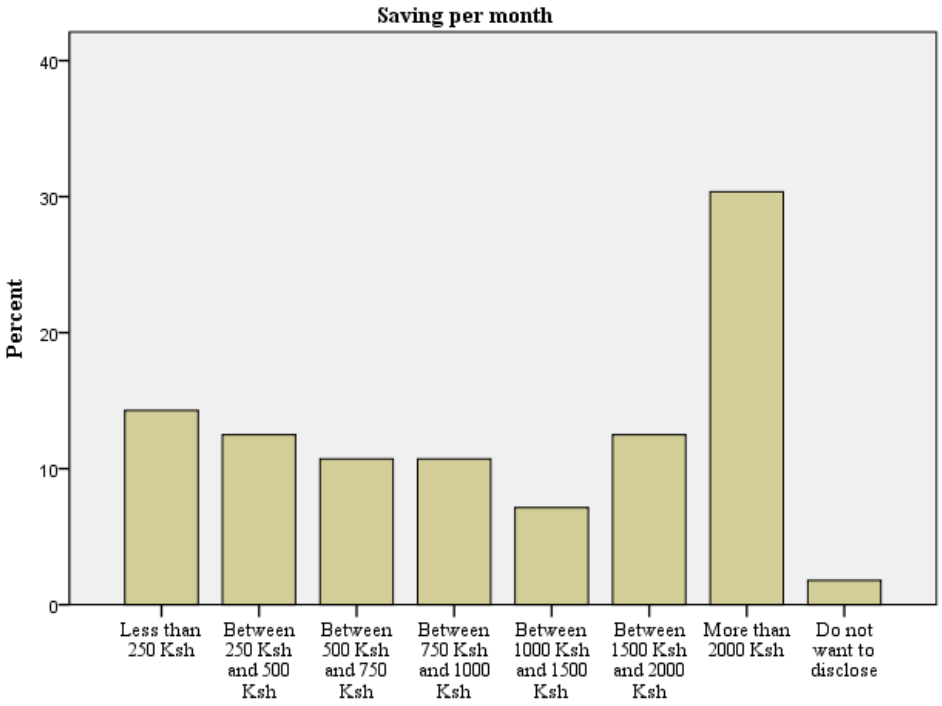

Fig. 14 – *Monetary savings per month (%)*

One would expect that household wealth would account for the fact that richer households save more per month than poorer households. In order to check this assumption, linear regression was performed. There was a negative but weak and not significant relation between total monetary value of livestock owned and monetary savings per month. There was a positive but

weak and not significant relation between asset index score and monetary savings per month. The regression equation for total monetary value of livestock owned was: total monetary savings per month = 1279 - 0.001 * monetary value of livestock owned, R^2 = .002, F(1, 39) = 0.070, p = .792 (table 10). The regression equation for asset index score was: total monetary savings per month = 1209,42 + 49,72 * asset index score, R^2 = .028, F(1, 53) = 1,542, p = .220 (table 11).

	Model Summary					Parameter Estimates	
Equation	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.002	.070	1	39	.792	1279.094	-.001

Tab. 10 - *Regression output with total monetary value of livestock owned to monetary savings per month*

	Model Summary					Parameter Estimates	
Equation	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.028	1.542	1	53	.220	1209.423	49.721

Tab. 11 - *Regression output with asset index score to monetary savings per month*

When I asked respondents about their total monetary savings, 60% said their savings were 10,000Ksh or less, with the largest group (28,6%) having savings between 1000Ksh and 5000Ksh. In addition, 10,7% said their savings were between 10,000Ksh and 25,000Ksh, while a considerable 12,5% said their savings totaled more than 25,000Ksh. There were respondents (16,1%) who did not want to disclose their savings, while some (1,8%) said they did not know the amount of savings they accumulated (figure 16).

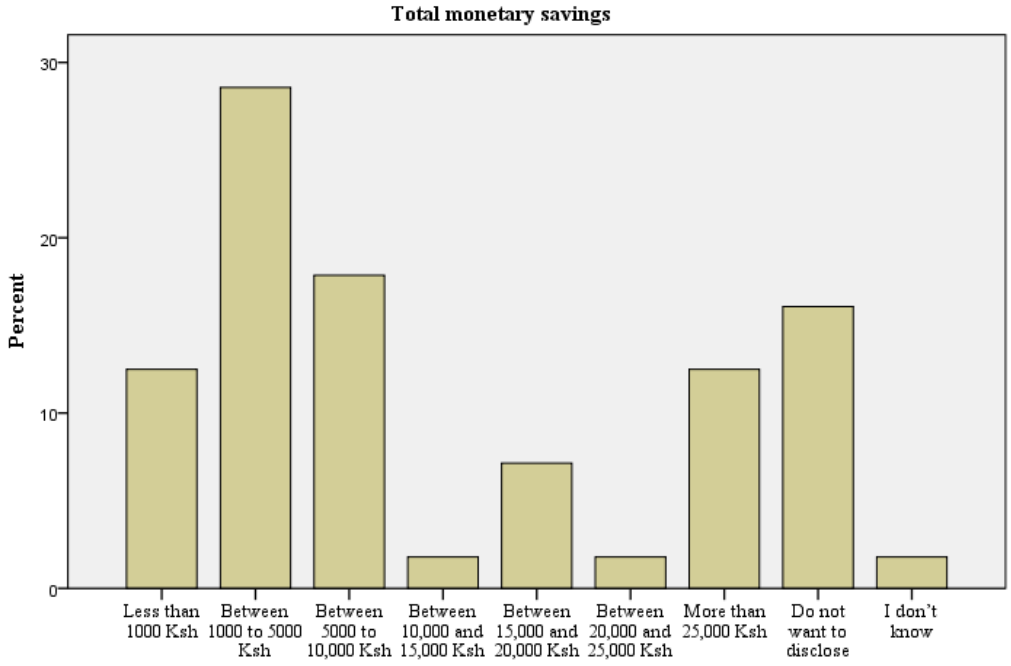

Fig. 15 – *Total monetary savings (%)*

One would again expect that wealthier households would have a more monetary savings than poorer households. In order to check this assumption, linear regression was performed. There was a positive but weak and not significant relation between total monetary value of livestock owned and total monetary savings. There was a positive and significant relation between asset index score and total monetary savings. The regression equation for total monetary value of livestock owned was: total monetary savings = 7923 + 0.035 * monetary value of livestock owned, R^2 = .070, F(1, 32) = 2.427, p = .129 (table 12). The regression equation for asset index score was: total monetary savings = 8758.807+ 1390,84 * asset index score, R^2 = .150, F(1, 44) = 7.781, p = .008 (table 13).

	Model Summary					Parameter Estimates	
Equation	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.070	2.427	1	32	.129	7923.031	.035

Tab. 12 - *Regression output with total monetary value of livestock owned to variable total monetary savings*

	Model Summary					Parameter Estimates	
Equation	R Square	F	df1	df2	Sig.	Constant	b1
Linear	.150	7.781	1	44	.008*	8758.807	1390.842

*Significant value (α< 0.05)

Tab. 13 - *Regression output with asset index score to total monetary savings*

Conclusion

Interviews with the five finance professionals provided a firsthand view on the history and current saving culture on Rusinga and in the Mbita region. The Lhuo culture was characterized as not being a distinct saving culture, however, the saving culture in the Mbita region is developing. Four of the five professionals expected that saving through banks will increase in the near future, a development that is underlined with three banks opening branches in Mbita in the coming two years, increasing the number to six available banks in total.

The finance professionals estimated that between 15 to 30% of the households on Rusinga was saving. The survey showed that 56% was saving; I will come back to this significant difference in the discussion. In both the interviews and the FGDs it was said that women save more than men, however, from the survey it seemed that slightly more men are saving. It was also said during the FGDs and the interviews that specifically people active in the fishing business do not save. Although it was found that a considerable group (33%) of respondents active in fishing did not save, the results are not conclusive enough to make any strong conclusions in regard to this claim. With respect to age, there are many people not saving in the younger and older age brackets. Taking into account the strong family ties in Lhuo culture, it is possible that they are being supported by their social network.

Saving through banks is preferred by most respondents, followed by saving through M-Pesa/M-Shwari and group saving. Saving by investing in livestock is not common at all. Supply and demand side barriers were mentioned for each saving option and were related to all five saving barriers mentioned in theory; transaction costs, regulatory barriers, social constraints, behavioral biases and lack of financial knowledge. The most important barriers mentioned were lack of funds and/or unemployment. During the FGDs, participants pointed out several possible solutions for these barriers, for example bringing banks closer to people by opening small shops on the Island, increase financial knowledge through education or by depositing large sums of money at once in order to mitigate transaction fees. In the discussion I will further elaborate on the savings barriers and the advantages and disadvantages of each saving option.

Despite the current saving barriers, 30% of the respondents who saved said they were saving more than 2000Ksh (€20,70) per month, and although 59% found saving difficult, still 42,5% managed to save 1500Ksh (€15,50) or more per month. To put these figures in perspective: the gross national income per capita in Kenya in 2013 was 85,303Ksh (€883,75) (UNICEF, 2015). In regard to total monetary savings owned, the majority of the respondents (60%) said their savings totaled 10,000Ksh (€103,60) or less, with the largest group (28,6%) have savings between 1000 and 5000Ksh (€10,35 and €51,75). This shows that although 42,5% of the people who saved, managed to save 1500Ksh per month, a large group was not able to accumulate more than 10,000Ksh in total, even though there was also a considerable group of 12,5% that saved more than 25,000Ksh (€258,70).

The richest households are saving more – in terms of number of households – than the poorest households. However, there is no significant linear relationship between the total monetary value of livestock owned or asset index score and the amount of money saved per month. There is also no significant linear relationship between total monetary value of livestock owned and total monetary savings, but there is a significant linear relationship between asset index score and total monetary savings. It can be concluded that total monetary value of livestock owned is not a significant predictor of the amount of money households save in monetary terms. The amount of valuable assets owned is also not a significant predictor of the amount of money saved each month, but there is a significant linear relationship between the amount of valuable assets owned and total monetary savings.

Most suitable saving option to enable households to maintain their SMoT

Interviews finance professionals

In regard to the most suitable saving option to organize money saving to maintaining the SMoTs, the professionals thought poorer households would prefer to save collectively whereas richer households would prefer to save individually to maintain their SMoT. Moreover, two professionals said women would likely prefer to maintain the SMoTs collectively whereas men would prefer to do this individually (Co-op branch manager, 2014; KWFT business development officer, 2014). The women's group coordinator (2014), pointed out that the poorest people should start saving as soon as possible so they have enough time to build up reserves. The Co-op branch manager (2014) argued that although group saving might be preferred for and by some people, formal group saving does not work well in the Mbita region, a statement he based

on the low success rates of saving groups registered at Co-operative Bank. In his opinion, informal saving groups, such as the ones coordinated by the women's group coordinator are mainly successful because she spends a lot of time with each group. Banks like the Co-operative Bank cannot offer this service as this is too costly. He suggested to start with an individual saving program which could be graduated to a program that incorporated group saving. This approach would make it possible to identify individuals who have no problem saving (in his experience 2/3 people per group of 12 are excellent savers) who could then function as mentors for people who find it more difficult to save.

FGDs

During the FGDs, an interesting dynamic occurred. In each FGD, the participants concluded that the poorest people on Rusinga needed to be helped in saving money to maintain their SMoT. As such, group saving would be the best solution. Moreover, the opinion leaders thought it would foster collective responsibility for the maintenance of the SMoTs and the control of malaria. Still, in the end, each group decided that saving individually – through banks - would be preferable, as the perceived benefits of the SMoT are mostly personal and because group saving will likely not work due to conflict. In every FGD, participants concluded that the SMoT is a personal asset, not a collective one.

Survey

During the survey, 64% of the respondents answered they preferred saving individually to maintain their SMoT, leaving 36% who preferred to save collectively. The most heard reasons to save individually were 'because I see it as a personal asset' (34%), 'group saving suffers from conflict' (31%) and 'individually is more convenient' (19%). The reasons to save collectively were more diverse but concentrated on the facts that it is easier to save in a group, that group saving allows to exchange ideas and knowledge, that poor people cannot save on their own and that the SMoT is a collective rather than an individual asset. During the survey, the wealthiest households did express more preference to save individually to maintain their SMoT compared to poorest households (table 14), confirming the assumption of the finance professionals, although there exists no clear linear relationship. In line with the general saving preferences of men and women, men preferred to save individually to maintain their SMoT compared to women (table 15).

	Household wealth	Total

		Poorest group (%)	Second group (%)	Third group (%)	Richest group (%)	
Saving for SMoT	Individually	12 (52)	24 (80)	14 (52)	14 (67)	64
	Collectively	11 (48)	6 (20)	12 (48)	7 (33)	36
Total		23	30	26	21	100

Tab. 14 – *Cross tabulation of saving for SMoT versus household wealth*

		Gender		
		Male	Female	Total
Saving for SMoT	Individually (%)	34 (53)	30 (47)	64
	Collectively (%)	14 (39)	22 (61)	36
Total		48	52	100

Tab. 15 – Cross tabulation of saving for SMoT versus gender

Conclusion

Considering that 64% preferred to save individually to maintain their SMoT and that 40% primarily saves at banks, it seems that the most suitable saving option which enables households to maintain their SMoT in general, is saving individually through banks. At the same time, there is a considerable group that preferred to save collectively to maintain their SMoT. This finding, coupled with the finding that households on Rusinga have heterogeneous preferences towards the available saving products, raises the question whether there is one single suitable saving option that can be used to organize saving to maintain the SMoTs. I will come back to this issue in the discussion.

6. Discussion

The aim of this research was to study how the Rusinga community can organize money saving to maintain the SMoTs beyond 2015. In doing so, it sought answers to the questions of how households perceive the SMoT, how much money they save using the SMoT, whether and how much households are willing to pay for maintenance, which saving options households have access to and which saving option is the most suitable to enable households to save money to maintain the SMoTs.

Perception of the SMoT

The results show that the general perception of the SMoT is positive, and that the mobile phone charger and especially the LEDs are seen as important components of the SMoT. Both increase

the general quality of life and using them clearly saves households' considerable amounts of money. In regard to the trap, however, the mixed results raise the question how many people *really* see the trap as a preventive health measure that reduces malaria. It is possible that some people say – when asked directly – that the trap works as a preventive health measure due to social desirability. The community of Rusinga has been visited by many NGOs, government agencies and researchers over the last 20 years. People are used talking to project staff and are aware they should not jeopardize projects by giving 'wrong' answers, or as one of SolarMal project staff told me: 'Once they see a white person, everything is okay'.

Another explanation could be that, although people are being told the trap is a preventive health tool that has the potential to control malaria, it is not proven yet that it actually does. Hence, people say they see the trap as a preventive health measure but the actual importance of the trap relative to the other components remains low until it is proven that the trap works. Assuming that the trap will be able to control malaria on Rusinga, it is crucial to inform households as soon as possible about its function as a preventive health measure as research shows that this can increase its use substantially, as household health behavior is quite responsive to information (Madajewicz et al., 2007; Rhee et al., 2005). A third explanation could be that the benefits of the trap are more abstract than the benefits of the LEDs and the mobile phone charger, making it difficult for people to fully comprehend its value. For example, the savings on kerosene are easier to understand and calculate than the savings on malaria treatment and lost labor/school days. Improving peoples' understanding of the financial benefits of the trap – again, when it works – may well be crucial in the adoption of the trap as a preventive health measure.

Savings attributed to the SMoT

Almost on third (29%) of the households saved 400Ksh or more per month using the LEDs. In regard to the mobile phone charger, more than one third (36%) of the households said they saved 100Ksh or less per month. Still, a considerable 18% saved 400Ksh or more per month. These figures show that both the LEDs and the mobile phone charger are helping households to save money and this partly explains why the perception of respondents of both components is (very) positive.

It was impossible to directly ask the respondents to the money saved using the trap. However, the results showed that households spend on average 315Ksh on treatment costs per malaria case. This implies that households *can* save considerable amounts of money using the trap if it

works. However, as mentioned above, in informal talks during the survey – but also the FGDs – I got the impression that people are not (fully) aware of the amount of money they can save using the trap. This may well be related to the fact that savings from the trap are more abstract – especially in regard to lost labor or school days – and less evident than savings from the LEDs and the mobile phone charger. If my assumption is correct, providing people with information on the amount of money they can save using the trap could help households in making informed decisions on the costs and benefits of the trap as a preventive health measure. It could also increase the importance of the trap relative to the other components of the SMoT. Further research is necessary to be sure if this is the case and if so, to see which household members need what sort of information. This is important, as various studies reject the unitary model of the household. For example, there is evidence that women and men value child health differently, and therefore respond to information on the return on preventive health measures differently (Duflo, 2003; Qian, 2008).

Willingness to pay for the SMoT

Following up on the above, it would be have been interesting to analyze if there is a difference in willingness to pay (WTP) between households with and without children or men and women. Some studies show that women invest more time and money in preventive health measures and the overall welfare of their household than men (Duflo, 2003). Moreover, it was said during the FGDs that women on Rusinga are more concerned with the SMoTs in general than men (although women did not point out the trap as the most important service of the trap more than men). This could mean that they are also willing to pay more to maintain them. However, due to the benchmarking of the base price this was not possible.

From the survey it seems that respondents' WTP is on average 424Ksh per month to maintain their SMoT and 164Ksh per month to maintain the solar panel and trap only. Still, since the initial base price was too low for many interviews, the real WTP is likely higher for both. I estimate that the real WTP for the SMoT is in the order of 800Ksh, but further research is necessary to confirm this.

Important to point out is that a households' WTP can be higher than the actual ability to pay (ATP). Subsequent research should take this into account as the results of this study hint to the fact that the WTP value of (some) households to maintain their SMoT is higher than their ATP. A usual assumption of the contingent valuation method is that WTP and ATP are related in the

sense that respondents who declare willing to pay the price should be, somehow, able to do so (Mataria, Giacaman, Khatib, & Moatti, 2006). In practice, this assumption may not hold. As both Ajzen, Rosenthal, and Brown (2000) and Walton, Thomas, and Cenek (2004) argue, WTP values are based on psychological considerations and respondents may give a high value of WTP for a good service even if they cannot afford it. For example, in rural Tanzania, Saulo, Forsberg, Premji, Montgomery, and Bjorkman (2008) found that households' WTP for artemisinin-based combination therapy (a first-line treatment for uncomplicated malaria) was higher than their ATP. In this study, one would assume that a household who does not save, express a lower ATP and thus also a lower WTP in comparison to a household who does save. However, some households who do not save express a high WTP value. Further research should make a clear distinction between households' WTP and ATP for the SMoT.

Saving culture and saving options on Rusinga

The saving culture in the Mbita region is developing. According to the survey, 56% of the households living on Rusinga currently save. This is considerably higher than was proposed by the financial professionals who estimated that between 15 to 30% is saving. However, a household survey performed by FSD Kenya in 2009, found that 52% of Kenyans used at least one saving product, including informal saving instruments. This figure is more consistent with the survey result and it seems that the estimation of the professionals was too low, maybe because they focused on saving at banks solely.

The three existing saving instruments on Rusinga, listed in order of importance, were; banking, M-Pesa/M-Shwari, and group saving. Respondents said they have enough options to save. It was found that men mainly save at banks while women prefer saving in groups. Fishermen and youth both primarily use M-Pesa/M-Shwari. During the survey, respondents pointed out many different demand and supply-side barriers in regard to the three main saving options. In fact, all five saving barriers that were identified in chapter two were mentioned; transaction costs, trust issues, financial illiteracy, social constraints and behavioral challenges. However, there was one main-demand side barriers causing people to have trouble saving or to not save at all: lack of funds.

Banks were frequently named as the safest place to store and save money. The possibility of gaining interest and taking loans were also declared an advantage, as well as the physical distance which makes it harder to withdraw money. This last reply is interesting as it shows that

people are aware of their own impulsive behavior and seek ways to control it. At the same time, distance was also mentioned as a disadvantage as it increases transport costs (or transaction costs) and is not convenient. Other disadvantages named were low interest rates, high service charges and trust issues such as the risk of fraud. The perception of people that banks are prone to fraud could be a consequence of the fact the Kenyan banks have experienced quite a lot of fraud scandals over the last ten years (for a case study on fraud in the Kenyan banking sector see Akelola, 2012).

The mentioned advantages of M-Pesa/M-Shwari were its easy accessibility from the user's phone, the low user chargers (and thus low transaction costs) which makes it possible to save small amounts, and the fact that M-Pesa/M-Shwari agents are located close by to deposit and withdraw money. The only disadvantage that was named is that mobile network problems can occur. Convenience and low transactions costs are thus the main advantages of mobile saving, especially compared to saving at banks. This finding is in line with a study done by Zollmann and Collins (2010) in Kenya, who found that in choosing between M-Pesa/M-Shwari and a bank, the decision of the user is more a function of product details such as transactions costs and convenience rather than traditional measures such as financial knowledge, familiarity and confidence. It is still interesting, however, that people do not mention the lack of interest as a disadvantage. Possible explanations could be that (1) indeed convenience and user costs are more important than interest or (2) people save such small amounts that interest is not of any importance or (3) the interest at banks is so low that people do not bother or (4) people do receive interest. Even though M-Pesa does not offer interest over savings, M-Shwari does so since last year, offering its customers to save a minimum of 500Ksh for a maximum period of six months, with interest rates up to 6% (Safaricom, 2015). Although I have not researched it specifically, not one respondent mentioned this service so I assume not many, if one, of the respondents used it.

In regard to group saving, respondents said its advantages were that group meetings are close by, it is encouraging (or limits time inconsistent behavior), and it makes it possible to easily share ideas on saving. The possibility of interest and taking loans were also mentioned as an advantage; one respondent explained that some informal saving groups deposit the collected sum in a bank account so that the money gains interest. Group members also give out loans to each other (with interest). Dishonesty by group members, late repayment issues, misuse of funds by group leaders, and the time consuming character of group saving were mentioned as

disadvantages. From these responses, one could argue that group saving functions as a hybrid saving option, combining the advantages of mobile saving and saving at banks. The fact that meetings are close by and money is collected and deposited in one time lowers transaction costs and is convenient. Once the sum is deposited in a bank account it gains interest, and just as with banks, group members can get a loan, in this case from group members.

Despite the existing saving barriers, the survey results showed that almost one third (28%) of the Rusinga population was saving 1000Ksh or more per month. In contrast, a little under one third (27%) was saving 1000Ksh or less per month while 44% was not saving at all (and 1% did not want to disclose their monthly savings). Assuming that respondents took the savings attributed to the system into account, it is interesting to note that 27% of the Rusinga community was saving less than 1000Ksh per month. The savings on kerosene, mobile phone charging and (possibly) malaria treatment seem to be considerable for most households, which implies that for this group, the current total monthly household savings can be largely attributed to the system.

Calculating exactly how much people need to save to maintain the SMoT per month is beyond the scope of this research, as it is not clear yet how much the components will cost in 2016. However, using a (very) simplified calculation it can be estimated that households need to invest €65,- per year or €5,40,- per month (608Ksh) to maintain their SMoT (table 16).

Component	**Price (€)**	**Replaced in … years**	**Cost per year (€)**
Trap	70	3	23,30
Battery	29	5	5,30
Solar panel	22,50	15	1,5
Controller	11,60	5	2,30
Box	7	5	1,4
LEDs	7	1	7
		Total costs per system per year	41,30
		Total costs per system per year including shipping and installment costs	65

Tab. 16 – *Estimated maintenance costs for one SMoT (per year)*

This calculation only uses the current component costs of the most valuable components (thus excluding the costs of smaller parts such fittings and switches). Both the timespan (years) in which each component needs to be replaced, and the shipping and installment costs are estimated. Component costs are not corrected for inflation. Important to note is that in this calculation the trap is treated as if it needs to be replaced in its entirety every three years. However, the trap consists of different components which can be replaced separately, so it is likely that its actual replacement costs are less than €23,30,- per year.

Considering the estimated maintenance costs of 608Ksh per month, especially the group that was not saving (44%) – which compromises almost half of the total Rusinga population and consists mostly of unemployed people, people active in the fishing business and youngsters – could have difficulty saving enough money to maintain their SMoT due to a lack of funds. The second group (27%) which was saving 1000Ksh or less per month may also have trouble saving enough, while the last group (28%), which was saving 1000Ksh per month or more, could be expected to be able to maintain their SMoT.

Most suitable saving option to enable households to maintain their SMoT

Taking the above into account, what would be the most suitable way to organize money saving in order to enable households to accumulate enough savings to maintain their SMoT? During the survey, 64% of the respondents answered they preferred to save individually to maintain their SMoT, as most found it a personal asset. Others remarks where that saving individually is more convenient and that group saving suffers from conflict. Still, 36% of the respondents preferred to save collectively to maintain their SMoT, as they saw the SMoT as a collective asset and found saving in groups more convenient.

Considering that 40% of those who save, prefer to save at a bank, the option to save individually through banks seems to be the most *preferred* saving option. However, considering the heterogeneous preferences of households towards the available saving products and to how to specifically save for maintaining the SMoTs, it is questionable whether saving through banks is the most *suitable* saving option for each household. Moreover, the identified demand-side and supply-side barriers of banking on Rusinga highlight the question that if saving at banks would become more accessible for the community, would this facilitate saving for the SMoT, taking into account that many respondents see the lack of funds as the main barrier to saving? This

last point is actually applicable on each saving option. Whether it is saving through banks, via M-Pesa/M-Shwari or in groups; people need to have enough funds in order to save. Seeing that income on Rusinga is often highly seasonal and that 44% of the respondents say they do not save, this group could experience difficulties in saving consistently to maintain their SMoT, whichever saving option they use.

At this point it may be important to make a distinction between the LEDs and the mobile phone charger, and the trap. The private benefits of the LEDs and the mobile phone charger are the main reason why many households see (those parts of) the SMoT as a private asset. The trap, in comparison, provides a benefit that concerns the Rusigna community as a whole, namely the control of malaria on the island. Hence, it may be fruitful to treat the three components separate when talking about maintaining the SMoTs beyond 2015 and sustaining the SolarMal project. Considering the profound private (financial) benefits households experience from the LEDs and the mobile phone charger, and their relatively low maintenance costs, I expect that most households, even the 44% who do not save, will be able to maintain those parts of their SMoT. The poorest households may need financial help from their social network, but taking into account the strong social ties on Rusinga I do not expect this to be a huge problem. In regard to the trap, it is harder to say whether most households are willing and able to maintain it and see it as a preventive measure that can improve their health. Although this study shows that households are in favor of the trap in general, the results are mixed, and in addition, the trap is the most expensive component of the SMoT.

Hence, it could beneficial to start thinking of the trap as a public good, which it essentially is, as it is a good that is non-excludable and non-rivalrous, meaning that no household on Rusinga can be excluded from its benefits and the use of one trap by one household does not reduce its availability to others. By turning the traps into a public good, they would become a public responsibility and could be maintained by collecting tax money. This may even be inevitable when the results show that it is not necessary to fully cover Rusinga with traps to control malaria, as in that case, and in line with Tragedy of the Commons theory from Hardin (1968), the problem of free riding may occur. Some households may lose incentive to maintain their trap if they think it is sufficient if other households maintain theirs. Or, it could be that some households do not agree with the fact that they are responsible for maintaining their system while others benefit. Still, several challenges can arise when turning the trap into a public good. For example, there is a high level of population mobility at the fishing beaches which could

make the collection of taxes difficult in those areas. It does also not present a solution for the poorest households as their lack of funds may still be an issue in paying taxes. Further research is necessary to explore the possibilities to maintain the trap as a public good.

This study has sought to answer the question how the Rusinga community can organize money saving to maintain the SMoTs beyond 2015. It can be concluded there exists no single most suitable saving option to enable all households to save money in order to maintain their SMoT. This is due to households' heterogeneous saving preferences, which are the result of existing saving barriers that differ per saving option. The general perception of households towards the SMoT is (very) positive, especially in regard to the LEDs and the mobile phone charger. Both components increase the quality of life substantially and most households save considerable amounts of money using them. In regard to the trap, the general perception seems positive, although the results are mixed. The main reasons for this seem to be that households are not sure yet if the trap works as a preventive health measure and because the savings from the trap are less evident compared to the savings from the other two components. Considering the high private returns and the low maintenance costs of both the LEDs and the mobile phone charger, I expect that even households who were not saving (44% of the total population) will be able to maintain both components. Taking into account the ambivalent attitude towards the trap, and the fact that it is the most expensive component of the SMoT to maintain, it is hard to say at this point whether most households are willing and able to maintain it. Seeing there is not one most suitable saving option to organize money saving for maintenance, and the fact the trap is essentially a public good, this study proposes to look at the option of maintaining it using tax money.

7. Recommendations

Based on the results and discussion, this chapter contains various recommendations to help direct the thinking on sustaining the SolarMal project beyond 2015.

Recommendation 1 – Define what 'sustaining the SolarMal project beyond 2015' means

This study is part of the broader question of how to sustain the SolarMal project beyond 2015. Before taking any action it is important to create a definition in regard to what is meant with 'sustaining the SolarMal project', as this forces you to think what is necessary to call the SolarMal project 'successfully sustained' and to see whether this definition is shared among the project staff and between the project staff and the community. So far, various FGDs and interviews have taken place and the current consensus is that the term sustainability of SolarMal means keeping all SMoTs (including LEDS, phone charger and trap) working plus the availability of a technical team to carry out maintenance work. As the project continues and more information becomes available, it is likely that the definition will change. For example, results could reveal that more traps are needed, that one trap per three houses is sufficient or that the trap is not sufficient for malaria control at all. The definition of 'sustaining the SolarMal project' should be changed accordingly and shared among the project staff and the community.

Recommendation 2 – Decide on the capability of SolarMal to control sustaining the project

Following up on that, the SolarMal project should analyze which capabilities it has to control the sustainment of the project beyond 2015. Will it claim a facilitating role, for example, by helping the community in creating a sustainability plan, or does it want to have a leading role, for example by setting up service which will be responsible for collecting taxes for the maintenance of the trap.

The decision seems to depend for a large part on the recourses (time, money) SolarMal has available over the course of 2015. Whatever strategy will be used, it is important to take into account the preferences of the community and to choose targets that are feasible.

Recommendation 3 – Inform the community on the effectiveness of the trap as a tool to control malaria soon as possible

It is crucial to inform households about the ability of the trap to control malaria as soon as possible. Research has shown that providing information on the effectiveness of a preventive

health measure can have significant impact on health behavior in the sense that households invest more in preventive health care if they know it works. Important to bear in mind is that the impact depends on which information is given to whom (Madajewicz et al., 2007; Rhee et al., 2005)

Recommendation 4 – Inform the community on the financial benefits of the trap as soon as possible

It seems that people are not fully aware of the financial benefits the trap can provide. A reason for this may be that the financial benefits of the trap are not easy to understand because they are rather abstract, especially in comparison to the LEDs and the mobile phone charger. By informing the community about the financial benefits of the trap, my assumption is that households are able make a better informed decision on its costs and benefits.

Recommendation 5 – Keep track of the general perception of the trap

Previous research has shown that households not only learn about the effectiveness of a preventive health measure themselves but also through their peers (Dupas, 2011; Holla & Kremer, 2009). People need time to experiment and see others experiment to become convinced of the benefits of the trap. It is useful to keep track of the general perception of the trap among the population, as this is an indicator of the possible take-up of the trap as a preventive health measure.

Recommendation 6 – Acknowledge there is no 'one size fits all' package

Due to the heterogeneous character of the Rusinga population there exists not one single saving option that is most suitable for all households. Therefore, it may be necessary to prioritize; if households will be individually responsible for maintaining their trap, it could be an option to particularly support the poorest segment of the Rusinga population in maintaining their SMoT. The priority chosen has consequences for the saving product design.

Recommendation 7 – Investigate the possibility to turn the trap into a public good

Taking the above into account, it would be worth the effort to explore the possibility of turning the trap into a public good and maintaining the desired number of traps using tax money. This way, the traps would become a public responsibility. However, making the trap a public good will result in other challenges and further research is necessary to map out the advantages and disadvantages of this option.

Recommendation 8 – Be prepared for the problem of free-riding/tragedy of the commons

It is possible that some households may choose not to maintain their SMoT, even if they do have sufficient access to saving options or credit. In the case of the trap, it could be possible that some households will underinvest in maintaining their trap as the direct private returns seem to be low. What could also happen is that, some households will lose incentive to maintain the trap as they think it is sufficient if other households maintain theirs in order to control malaria or because they do not agree that they are responsible for maintaining their system while others benefit.

Recommendation 9 – Make sure SMoT components are easy available immediately after the project ends

The availability of SMoT components is a premises of sustaining the SolarMal project. Even though the project staff is already contemplating on how to deal with this issue, it is not yet clear where or how components will be available in 2016. The way in which components will become available is closely related to which strategy for sustaining the SMoTs will be chosen, which is why it is important to choose and develop a specific strategy as soon as possible.

Recommendation 10 – Consider mobile phone messaging to help households save (or pay their taxes)

Considering that 95% of the respondents said they own mobile phone and the fact that the HDSS team created a database of all participating households in the SolarMal project containing their mobile phone contact information, it could be well possible to use mobile phone messaging to remind people to save (or pay their taxes). Karlan et al. (2010) argue that reminders are most effective on time-inconsistent individuals and other studies show that mobile phone messaging can be a powerful tool in lowering transaction costs and enabling people to save consistently (Jack & Suri, 2014; Kast et al., 2012).

Recommendation 11 – Consider the trade-off between hard and soft-commitment saving

Studies show that there exists a trade-off between hard and soft-commitment saving products; households in low-income countries seem to benefit more from saving products that allow for some flexibility, given the risks and uncertainties they face. The option to withdraw money when needed, for example during a health emergency, often outweighs the benefits of committing to

long-term savings (Brune et al., 2011; Dupas & Robinson, 2013b). In thinking about how to design a supportive saving structure, it is important to keep in mind that households on Rusinga likely prefer soft-commitment saving products, as for many income is highly seasonal and the health burden of malaria and other illnesses is considerable.

Recommendation 12 - Analyze if and how existing social groups can be transformed in saving groups

Social groups are an important entity on Rusinga; 59% of the respondents reported they were member of a formally defined social group such as a self-help group, church group, youth group or women's' group. As these groups already exist it could be fruitful to see whether they can be used to motivate people to save or even be transformed into saving groups. The fact that members formed these groups themselves and know each other already can be an advantage, or as Shapiro (2010) argues; group saving works better in endogenously selected peer groups due to greater degree of concordance in preference.

Recommendation 13 – Consider the use of financial literacy programs

Both in the interviews with the finance professionals and during the FGDs, it was mentioned that financial education could help households to gain a better understanding of the benefits of saving. Although research shows that it is not clear whether financial illiteracy causes undersaving, it could be beneficial to start financial literacy programs. To develop such programs, a partnership with local banks might be an option as it is likely outside the scope and capability of the SolarMal project. Previous studies argue that simple and short programs in terms of content and time commitment yield the best results (Drexler et al., 2014; Hastings et al., 2012)

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Appendices

Appendix I – Price SMoT

Final cost price (at the factory) for the system materials			Amount (per system)	Total price per system (Euro)
	In Dollar	In Euro		
Battery		€ 29.00	1	€ 29.00
Panel		€ 22.50	1	€ 22.50
Controller	$15.50	€ 11.60	1	€ 11.60
LED's	$4.60	€ 3.45	2	€ 6.90
Box		€ 6.98	1	€ 6.98
Cable		€ 0.25	12	€ 3.05
Fittings		€ 1.23	2	€ 2.46
Angle Line	$2.08	€ 1.56	1	€ 1.56
USB charger	$1.13	€ 0.83	1	€ 0.83
Set of bolts nuts*		€ 0.70	1	€ 0.70
Switches		€ 0.39	2	€ 0.78
Clips		€ 0.05	10	€ 0.54
USB sockets	$0.34	€ 0.25	1	€ 0.25
Lugs / Shoes *		€ 0.05	4	€ 0.20
Tape		€ 0.10	1	€ 0.10
Glue		€ 0.03	1	€ 0.03
Tools and extra cost		€ 0.50	1	€ 0.50
Suna trap		€ 70.00	1	€ 70.00
Total per system				**€ 157.97**
*estimated maximum				
Conversion: 1 dollar = 0,75 Euro.				
Costs do not include tax and shipping.				

Appendix II – Focus Group Discussions Questions

1. Introducing the reason for the FGD (money saving for SMoT, but also interested in saving on Rusinga in general)
2. Introducing ourselves
3. Ask the participants to introduce themselves (name, age, village, occupation?)
4. Explain discussion rules (open discussion, we want to hear each opinion, no opinion is wrong, feel free to say anything, please put your phone silent)

Watch out for easy answers. Try to lead them through the questions without steering answers. Please keep it as focused as possible.

Note: the focus is first on saving in general, in question (4), (5) and (6) the focus shifts to saving in order to maintain the system. Do not read words in italic out loud.

Maximum total duration: two hours.

Question 1 – Saving (15 min)

Are people saving money on Rusinga? Could you give a percentage of how many people roughly save on Rusinga?

Whom are saving? (*nb. can be explained by profession or age/gender etc.*)

How do they save? Which saving options do they use primarily?

Who in the household saves primarily?

For what are they saving?

Question 2 – Saving challenges (30 min)

Are you saving money? *(nb. can be made general: e.g. Are fishermen saving money?)*

If yes, how? If no, why not?

Do you find it easy or difficult to save money?

Why do you find it easy to save money?

Why do you find it difficult to save money and what are the main challenges for you to save money?

Is it related to access to saving options? *(nb. thus: do you have easy access to saving options? If not, what difficulties do you encounter?)*

Is it related to your own behavior? How? *(nb. can be generalized to 'people's behavior')*

Is it related to the social environment you live in? How?

How do you think you can overcome those challenges? What kind of incentives would help you to save*? (nb. thus: saving options, social environment, own behavior) (with regard to incentives, try to let them answer specifically which things they think could help them personally to save, so not something general like 'education')*

Question 3 – Saving options (15 min)

What do you think could be other options to save money than we discussed to so far? How many options to save can you think of?

From all saving options we discussed, what would be most suitable for the Rusinga community? (*nb. individual through banks/mobile phone use or group saving etc. – don't read out loud please) (if this question is to difficult first ask what is the most suitable option for their group)*

Question 4 – SMOT (30 min)

What is your opinion about the workings of the SMOT system so far?

Which service of the system is most valuable to you? Why?

Which amount of money do you think you save in total per month using the SMOT? (*break down in a) indoor lightning b) the mobile phone charger c) the malaria trap)*

Which household member primarily maintains the system?

Do you find that the malaria trap works? Are you less bitten by mosquitoes?

Do you think the trap will reduce malaria from the island?

Are you willing to maintain the trap?

Are you aware that you will be the owner of the SMOT in 2016?

Do you see the system as a personal asset or as a community asset?

Do you think money investment in maintenance should be arranged personally or collectively? *(nb. try to find out whether people think the poorest people will be left out/are not able to save on their own and if this is the reason they would go for collective saving)*

Question 5 – Willingness to pay (20 min) (if people draw up the 500Khs issue here, explain)

Are you willing and able to pay for maintaining the system?

If yes, how much? Take your time to consider: what is the maximum amount you want to spend per month on maintenance costs for the whole system? And for only the solar panel and the trap? *(nb. please do ask this question, even if the general feeling is that people do not want to maintain the trap)*

If no, are you not willing or able? Why are you not willing? Why are you not able?

Question 6 – Saving for SMOT (15 min)

Which saving option do you think is most suitable for maintaining the system? Is the most suitable saving option for Rusinga in general also the most suitable option to use to save for maintenance of the system? Why? Why not?

Question 7 (5 min)

Thank you for this FGD, is there anything else you would like to say?

Appendix III – Focus Group Discussions Photo's

Appendix IV – Survey Questions

Questionnaire number: _____
SolarMal household ID: _____
Interviewer: _____
Interview date: _____
Time interview began: _____
Time interview finished: _____

INTRODUCTION

Hi, my name is ... and I am here on behalf of ICIPE and the SolarMal project. The purpose of my visit is to ask you some questions about how your family experiences malaria and how you save money. The information will be kept confidential and you can withdraw participation at any time. The data will be analyzed and the results will be used to help the community develop an action plan for sustaining the SMoTs after 2015. The total interview time will be approximately 30 minutes. Thank you for your cooperation.

0. What is the gender of the interviewee?
   - ☐ Female
   - ☐ Male

1. How old are you?
   Age: _____

2. What is your marital status?
   - ☐ Married
   - ☐ Widowed, separated, divorced
   - ☐ Single

3. What is the highest education level you completed?
   - ☐ No grade completed
   - ☐ Primary school
   - ☐ Secondary school
   - ☐ College

4. Are you the head of the household?
   - ☐ Yes
   - ☐ No

5. How many people falling in the given age bracket belong to your household?

a. 0-5 years _____
b. 6-15 years _____
c. 16-25 years _____
d. 26-40 years _____
e. 41-60 years _____
f. over 60 years _____

6. What is the living arrangement of the household in this house?

☐ Owns the house
☐ Rents the house for _____ Ksh per _____
☐ Other arrangement, _____

7. Of the following list, which belongings does your household have and how many? *(read out loud)*

a. ☐ House _____
b. ☐ Boat _____
c. ☐ Bed net _____
d. ☐ Bicycle _____
e. ☐ Radio _____
f. ☐ TV _____
g. ☐ Refrigerator _____
h. ☐ Motor cycle _____
i. ☐ Generator _____
j. ☐ Car battery _____
k. ☐ Mobile phone _____

8. Do you own farm land?

☐ Yes
☐ No

If yes, continue to question 9, if no go to question 10

9. How many acres is your farm land?

☐ Less than a quarter acre
☐ Half an acre
☐ One acre
☐ Two acres
☐ Three acres
☐ More than three acres
☐ Don't know

10. Do you own fishing equipment?

☐ Yes

☐ No

11. Do you own livestock? Which? How many?
    a. ☐ Cow, _____
    b. ☐ Donkey, _____
    c. ☐ Goat, _____
    d. ☐ Chicken, _____
    e. ☐ Sheep, _____
    f. ☐ I don't own livestock

12. Do you work outside the home?
    ☐ Yes
    ☐ No

If yes, continue to question 13, if no go to question 16.

13. What is your primary job (where you spend most time on)?
    Job: _____

14. Do you have a secondary job?
    ☐ Yes
    ☐ No

If yes, continue to question 15, of no go to question 16.

15. What is your secondary job?
    Job: _____
16. What kind of job does your spouse/partner have?
    ☐ Do not have a partner, go to question 18.
    ☐ Job: _____
    ☐ Does not work, go to question 18.

17. Does your spouse has a secondary job, if yes, what job?
    ☐ Yes, _____
    ☐ No

18. I would now like to talk more about saving money in general. Do you save money? If no, why not?
    ☐ Yes
    ☐ No, because:
    _____

    If yes, continue to question 19, if no go to question 29.

19. Do you find it difficult to save?

☐ Yes

☐ No

If yes, continue to question 20, if no go to question 21.

20. What is the primary reason you find it difficult to save?

_____

_____

21. Who in the household saves primarily?

☐ Me

☐ My spouse/partner

☐ Children

☐ Someone else, _____

22. How do you save money? (read out loud)	Yes	No
Using a bank account	☐	☐
Using M-Pesa/M-Shwari	☐	☐
Using a deposit box	☐	☐
Through table banking	☐	☐
Through merry go-round	☐	☐
Give savings to the chief	☐	☐
By investing in livestock	☐	☐
By investing in land	☐	☐
By investing in buildings	☐	☐
By investing in household items	☐	☐
Using cereal banking	☐	☐
By storing cash at home	☐	☐

23. Do you save money in any other way? How?

☐ Yes, _____

☐ No

24. Which saving option do you use primarily?

Saving option: _____

25. What are the three main advantages of this saving option?

1) _____

2) _____

3) _____

26. What are the three main disadvantages of this saving option?

1) _____
2) _____
3) _____

27. How much money do you save each month?

- ☐ Less than 250 Ksh
- ☐ Between 250 Ksh and 500 Ksh
- ☐ Between 500 Ksh and 750 Ksh
- ☐ Between 750 Ksh and 1000 Ksh
- ☐ Between 1000 Ksh and 1500 Ksh
- ☐ Between 1500 Ksh and 2000 Ksh
- ☐ More than 2000 Ksh
- ☐ Do not want to disclose
- ☐ I don't know

28. If you are comfortable sharing this information, how much monetary savings do you have in total?

- ☐ Less than 1000 Ksh
- ☐ Between 1000 to 5000 Ksh
- ☐ Between 5000 to 10,000 Ksh
- ☐ Between 10,000 and 15,000 Ksh
- ☐ Between 15,000 and 20,000 Ksh
- ☐ Between 20,000 and 25,000 Ksh
- ☐ More than 25,000 Ksh
- ☐ Do not want to disclose
- ☐ I don't know

29. You have received one SMOT system. In order of preference, which service of the system do you find most important? And which one after that? And after that?

1) _____
2) _____
3) _____
4) _____
5) _____

30. Who in your household primarily maintains the system?

- ☐ Me
- ☐ My spouse/partner
- ☐ Children

☐ Someone else, _____

31. How much money do you save per month using the indoor lightning (kerosene)?

☐ Less than 100 Ksh
☐ Between 100 Ksh and 150 Ksh
☐ Between 150 Ksh and 200 Ksh
☐ Between 200 Ksh and 250 Ksh
☐ Between 250 Ksh and 300 Ksh
☐ Between 300 Ksh and 350 Ksh
☐ Between 350 Ksh and 400 Ksh
☐ More than 400 Ksh

32. How much money do you save per month using the mobile phone charging point?

☐ Less than 100 Ksh
☐ Between 100 Ksh and 150 Ksh
☐ Between 150 Ksh and 200 Ksh
☐ Between 200 Ksh and 250 Ksh
☐ Between 250 Ksh and 300 Ksh
☐ Between 300 Ksh and 350 Ksh
☐ Between 350 Ksh and 400 Ksh
☐ More than 400 Ksh

33. If maintaining the system will cost 200 Khs per month, are you willing to pay this sum?

☐ Yes
☐ No

If yes go to question 34, if no go to question 37.

34. And if maintaining the system will cost (read out loud):	Yes	No
250 Ksh per month	☐	☐
300 Ksh per month	☐	☐
350 Ksh per month?	☐	☐
400 Ksh per month?	☐	☐
450 Ksh per month	☐	☐
500 Ksh per month	☐	☐
550 Ksh per month	☐	☐
600 Ksh per month	☐	☐
650 Ksh per month	☐	☐
700 Ksh per month	☐	☐
800 Ksh per month	☐	☐
900 Ksh per month	☐	☐
More than 1000 Ksh per month	☐	☐

35. Is this the absolute maximum amount you are willing to pay? If not, what would be the absolute maximum you are willing to pay to maintain the system?

☐ Yes, this is the absolute maximum amount I am willing to pay

☐ No, the absolute maximum amount I am willing to pay is _____ Ksh

36. Of this sum, how much money do you reserve to invest in maintenance of the trap?

Sum to invest in the trap: _____

Go to question 41.

37. If maintenance of the system will cost 50 Khs per month, are you willing to pay this sum?

☐ Yes

☐ No

If yes, continue to question 38, if no go to question 41.

38. And if maintenance of the system will cost:	Yes	No
75 Ksh per month	☐	☐
100 Ksh per month?	☐	☐
125 Ksh per month?	☐	☐
150 Ksh per month	☐	☐
175 Ksh per month	☐	☐

39. Is this the absolute maximum amount you are willing to pay? If not, what would be the absolute maximum you are willing to pay to maintain the system?

☐ Yes, this is the absolute maximum amount

☐ No, the absolute maximum amount I am willing to pay is _____ Ksh

40. Of this sum, how much money do you reserve to invest in maintenance of the trap?

Sum to invest in the trap: _____

41. Living on Rusinga, which diseases bother you the most in order of preference?

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

42. Do you and your household members receive fewer mosquito bites since you use the trap?

☐ Yes

☐ No

43. Do you and your household members experience fewer episodes of malaria since you use the trap?

☐ Yes
☐ No

44. Can you say how much you and your household members got infected by malaria in a period of three months before you had the trap?

☐ Yes, _____ infection(s) in three months
☐ No

45. Can you say how much you and your household members got infected by malaria in a period of three months now you use the trap?

☐ Yes, _____ infection(s) in three months
☐ No

46. How many labor days did your household lost due to a malaria infection in the last three months (January-March)?

Number of days: _____
☐ None
☐ Don't know.

47. How much money do you spend on average on malaria treatment when you or a household member gets malaria?

1) Transport costs: _____ Ksh
2) Check at health clinic: _____ Ksh
3) Malaria drugs: _____ Ksh
4) Other costs (indicate which): _____ Ksh

TOTAL COSTS: _____ Ksh

48. Do you see the trap as a preventive health measure which improves your health?

☐ Yes
☐ No

49. Do you prefer to save money individually or in a group to maintain the system? Why?

☐ Individually, because _____
☐ In a group, because _____

50. Are you member of a group/organization? For example, a self-help group, a women's group, a fisheries cooperative, ...? If yes, which?

☐ Yes, _____
☐ No

Thank you very much for participating in this questionnaire. Do you have any remaining questions for me?

To be filled in by interviewer

51. Material of house

Walls: _____ Roof: _____

52. Maintenance of trap

- ☐ Poor (a lot of dust, not emptied of mosquitoes, no fence)
- ☐ Average (dusty but not too much, reasonably empty, reasonable fence)
- ☐ Good (clean, emptied of mosquitoes, strong fence)

53. Remarks:

_____

Appendix V – Finance Professional Interview Questions

Question 1 - Saving

Are people saving money on Rusinga? Percentage?
Whom are saving?
Who in the household saves primarily?
For what are they saving?
How do they save?
Whom are not saving?
Why do they not save?
What are the main challenges for them to save money?

Question 2 - Saving challenges

What is needed to overcome those challenges?
Is it related to access to saving options? Is it easy for people to start saving? What difficulties do they encounter?
Is it related to their own behavior? How?
Is it related to the environment they live in? How?
How do you think they can overcome those challenges?
What kind of incentives would help them to save?

Question 3 - Saving options

What options to save money do people have?
Which one do they use most?
What is the role of banks in this?
From all saving options we discussed, what is the most suitable for the Rusinga community in general?

Question 4 - Saving for SMOT

Which saving option do you think is most suitable for maintaining the system? (way of saving; alone or in a group?)
Is the most suitable saving option for Rusinga in general also the most suitable option to use to save for maintenance of the system? Why? Why not?
If not, what would be a better saving option?

Question 5

Is there anything else you would like to say? Am I missing something?