



USAID | DELIVER PROJECT

LLIN Recycling Pilot Project Report on Phase II in Madagascar



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LLIN Recycling Pilot Project

Report on Phase II in Madagascar

USAID | DELIVER PROJECT, Task Order 3

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Abstract

In November 2010, the USAID | DELIVER PROJECT, Task Order 3, commenced a long-lasting insecticide-treated bed net (LLIN) recycling pilot project that examines the viability of recycling as an option for LLINs that have been retired as bed nets. The study is divided into three phases; Phase I - Feasibility; Phase II – LLIN Collection; Phase III – Recycling and Final Analysis.

The completed activities from Phase I are detailed in this document and the future activities of Phase III are mentioned, but the emphasis of this report is on Phase II. Through this pilot project, it was found that the collection of retired LLINs was both feasible and acceptable. This report details the methodology and findings related to the in-country collection of retired LLINs.

Cover photo: "Workers in Madagascar collect used long-lasting insecticide-treated bed nets for recycling. USAID | DELIVER PROJECT 2010.

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Acronyms

BCC	behavior change communication
CDC	Centers for Disease Control and Prevention
CHW	community health workers
CLR	Consortium Lova/Réssources Vertes
CNC	National Coordination Committee
CS	collection site
FKT	fokontany
HDPE	high-density polyethylene
IEC	information, education, and communication
LLIN	long-lasting insecticide-treated bed net
MOH	Ministry of Health
NGO	non-governmental organization
NMCP	National Malaria Control Program
PET	polyester
PMI	The President's Malaria Initiative
PSI	Population Services International
QSP	Quick Start Programme
RFP	request for proposal
SAICM	Strategic Approach to International Chemicals Management
SDP	service delivery point
TOT	training of trainers
UNEP	United Nations Environment Programme
USAID	U.S. Agency for International Development
USG	United States Government
WHO	World Health Organization
WHOPES	WHO Pesticide Evaluation Scheme

Executive Summary

Between 2004 and 2010, approximately 380 million long-lasting insecticide-treated bed nets (LLINs) were distributed in Africa to combat the spread of malaria (WHO 2010 report). Many of these LLINs, which have an estimated lifespan of three–five years or twenty washes, are now losing their efficacy. The impetus for the LLIN Recycling Pilot Project derived from the following concerns, raised by the World Health Organization (WHO) working group from the vector control branch and the President’s Malaria Initiative (PMI), regarding the impact of the continued presence of LLINs in communities as they reach or approach retirement:

- Insecticides remaining in LLINs that are repurposed for domestic reuse – i.e. as fishing nets, a cover for crops, mattress covers, shower curtains etc. – may potentially pose a risk to the environment and cause negative health consequences. Likewise, the improper disposal of LLINs may have a similar impact;
- Mosquito exposure to old or retired LLINs with substandard concentrations of insecticide may potentially have an impact on insecticide resistance (WHO 2010);
- Keeping LLINs in use that should be retired may decrease the uptake in the usage of new LLINs.

One option to address these concerns would be to retrieve retired LLINs from end-users. To that end, the USAID | DELIVER PROJECT Task Order 3 initiated an LLIN recycling pilot project – the first of its kind – that examines the viability of recycling as an option for LLINs that have been retired from use. The pilot project is divided into three phases: Phase I – Feasibility and Pre-Collection; Phase II – LLIN Collection; Phase III – Recycling and Final Analysis.

Phase I took place in March 2010. The objective of Phase I was to examine the feasibility of conducting a recycling pilot project in Madagascar. This consisted of a number of components: 1) hold discussions with key stakeholders regarding the feasibility of conducting a pilot; 2) develop consensus with in-country partners to conduct the pilot; 3) determine (through focus groups and individual interviews) whether people were willing to give up their current LLIN(s) for recycling; and 4) determine whether local infrastructure could support a pilot project.

During the pre-collection stage of Phase I, a pilot site was identified, as well as critical infrastructure requirements such as: compacting options, available warehousing, transportation and a port.

Initially, Phase II was intended to be implemented in conjunction with the 2009-2010 rolling LLIN distribution campaign. A contract to collect the old bed nets was issued to the same vendor that was responsible for distributing the new bed nets. Another contractor was identified to compact the LLINs and transport them to the port. Finally, Trex – a U.S.-based plastics recycling firm with previous experience working with pesticides – was identified to ship the LLINs to their facility in the United States to be recycled.

BCC/IEC materials were also designed and disseminated to community workers and fokotany chiefs to enable them to inform households about the pilot, and to organize and carry out collection activities in Phase II.

In November 2010, Phase II took place, shortly after the net distribution campaign. Over 22,000 retired LLINs were collected, sorted and shipped to Trex. At the time of this report's preparation, Phase III is ongoing. Trex is conducting a chemical analysis of the material properties of the collected polyester and polyethylene nets, and will ultimately recycle the nets into raw material to be used for building materials. This product evaluation will determine how much recycled polyethylene can be used in Trex products, and whether LLINs can also be recycled into other products. The results of this testing are not yet available.

The completed activities of Phase I and Phase II, and the future activities of Phase III are included in this report. However, the emphasis of this report is on the implementation of Phase II in Madagascar, including results and key findings. It was determined, through conducting this pilot project, that four primary factors affect the success of a recycling campaign: 1. the population's willingness to give back their retired LLINs, 2. whether LLINs have been collected from all potential collection sites (distance and poor access to roads can greatly affect this), 3. the communication strategy that is utilized (including what messages are disseminated and when, and who is involved), and 4. whether or not the distribution and collection campaigns have been planned as one project. In addition, factors such as timing of the two campaigns, and the availability local infrastructure (i.e. warehouses, transportation, a compactor etc.) also play a role.

Creating a successful recycling program in developing countries can be challenging, often because of insufficient waste management infrastructure and weak local governance. LLIN collection during a mass distribution campaign in Madagascar is also costly, on a pilot project scale. However, as our project demonstrates in this report, the collection of retired LLINs from households is logistically possible.

Introduction

LLINs, Malaria and the Environment

Distribution and use of LLINs is a proven malaria prevention strategy. As LLIN-use is scaled up in sub-Saharan Africa, the expectation is that both individual users and entire communities will be better protected from malaria. There is a suggested community-level, or mass effect, that occurs when there is broad coverage of LLINs in areas of intense malaria transmission, in that it may reduce the overall vector transmission potential (WHO 1995). Therefore, scaling up the use of LLINs not only benefits the people using them, but also others in the community who do not have or use LLINs.

However, the widespread use of LLINs across Africa has, simultaneously, raised concerns about the potential environmental impact of the large quantity of pesticide embedded non-biodegradable durable plastic nets being distributed. It underscores the importance of environmentally friendly practices and safe disposal, reuse, or recycling of retired LLINs. According to the Basel Convention that covers hazardous wastes, LLINs are not subject to controls. According to a WHO Pesticide Evaluation Scheme (WHOPES) study from six countries, between 30–80 percent of the original dose of residual pesticide was found in LLINs that were three-seven years old (WHOPES 12th working group report). An LLIN can have 0.2–8 grams of active ingredient, which is a lethal concentration of insecticide to some aquatic species (<1 µg/liter), including fish and other species that are caught when an LLIN is used as a fishing net (WHO 2010).

An estimated 380 million LLINs have been distributed through 2010, equaling approximately 125,000 metric tons of plastic polymers (Milliner 2010). While there is no conclusive evidence at present, it is possible that the sheer volume of LLINs in circulation potentially contributes to litter and contamination in the environment, particularly in areas with insufficient waste disposal, which is unfortunately common in many areas of Africa.

Prolonged use of old, expired, and ineffective LLINs may also influence individuals to delay using a new, more effective LLIN. This is often complicated by the fact that there is no standard definition of what constitutes an old or “expired” bed net, or specific guidelines regarding when an LLIN should be retired. Answers to these key questions are essential for determining which LLINs should be targeted for collection and recycling, or for safe reuse. WHO estimates that the lifespan of an LLIN could be between three-five years, or twenty washes. However, in carrying out this pilot study, we found that the strongest determinant of the life of an LLIN seems to be dependent on individual owner care, and perceptions of whether or not the net is still considered useful (refer to the findings section). In consultation with partners at WHO and PMI, for the purposes of this project, we defined a retired collection-ready net as one that is old and that the owner is voluntarily willing to give up for collection.

Pilot Project Format

The study is divided into three phases: Phase I – Feasibility; Phase II – LLIN Collection; Phase III – Recycling and Final Analysis.

The objective of Phase I was to examine the feasibility of conducting a recycling pilot project in Madagascar. This consisted of a number of components: 1) hold discussions with key stakeholders regarding the feasibility of conducting a pilot; 2) develop consensus with in-country partners to conduct the pilot; 3) determine (through focus groups and individual interviews) whether people were willing to give up their current LLIN for recycling; and 4) determine whether local infrastructure could support a pilot project.

From these initial steps, it was determined that a recycling pilot would be feasible, that people would be willing to return their retired LLINs and that critical infrastructure – such as available warehousing, transportation and compacting capacity – was in place.

Phase II consisted of five steps including:

1. **planning, design and development of the collection strategy.** This consisted of forecasting, logistics and other planning exercises;
2. **development and implementation of a communication strategy.** This included the development and dissemination of IEC/BCC materials and conducting trainings;
3. **site selection.** Six districts in southern Madagascar were chosen for the pilot—where the population of over 1.6 million is at risk for malaria;
4. **contracting of vendors.** The contract to collect retired LLINs was issued to the same sub-contractor (CLR) that was responsible for supporting the distribution of the new LLINs. Another contractor (Prorent) was identified to compact the LLINs and transport them to the port by truck, and Trex – a U.S.-based plastics recycling firm with previous experience working with pesticides – was identified to transport the nets by boat from the port in Madagascar to their recycling facility in the United States;
5. **physical collection of the nets.** The physical collection of the retired LLINs was carried out in six districts. The collection of retired LLINs was initially planned and designed to take place during the 2010 LLIN distribution campaign. However, for a variety of reasons (described in Phase II), most collection occurred after distribution had already concluded, during the post-campaign activities in November 2010.

Phase III is ongoing; the collected LLINs from Madagascar have arrived in the United States at Trex's facility. Trex is conducting a chemical analysis of the material properties of the collected polyester and polyethylene nets, and will ultimately recycle the nets into raw material to be used for building materials. This product evaluation will determine how much recycled polyethylene can be used in Trex products, and whether LLINs can also be recycled into other products. The results of this testing are not yet available.

Phase I – Feasibility

Madagascar is located off the eastern coast of Africa and has an estimated population of 21 million (INSTAT, 2010). The gross national income per capita is estimated at \$430 per day (World Bank 2009); an estimated 68 percent of the population lives below the national poverty line, and more than 70 percent live in rural areas in poor housing conditions. Malaria is endemic in 90 percent of the country (INSTAT, 2010), and the entire population is at risk for contracting the disease. It can be fatal for vulnerable groups such as pregnant women and children under five years of age.

LLIN Distribution in Madagascar

LLIN campaigns in Madagascar have improved access to malaria prevention methods for most of the rural population. According to the 2008–2009 Demographic and Health Survey, nearly two-thirds, or 68 percent of the population, owned a bed net (treated or untreated). However, net ownership (of at least one bed net) varies greatly by region. The highest ownership rates are in the region of Diana (89 percent) in the northern part of the country, and the lowest are in Itasy (7 percent) in the central part of the country (INSTAT, 2010).

In October 2007, the Ministry of Health and the Madagascar Red Cross and other international partners, launched a mass LLIN distribution campaign for children under five years of age. During this campaign more than 1.5 million Olyset (polyethylene) and Permanet (polyester) LLINs were distributed at the fokontany (FKT) level, the smallest administrative unit.

According to a post campaign, cross-sectional survey of LLIN ownership conducted six months after the 2007 campaign by Red Cross in the area (zones 1-2) where distribution had occurred, 76.8 percent of households owned at least one LLIN from any source and 56.4 percent of households had an LLIN from a public campaign. The public campaigns achieved an LLIN use target of ≥ 80 percent for children less than five years of age and a high level of LLIN use (69 percent) by pregnant women. Targeted LLIN distribution further contributed to total population coverage of 60 percent by all age groups (GFATM 2010).

Coordination Meetings

The Ministry of the Environment, Forestry, and Tourism, and the Ministry of Health were concerned about the possible negative environmental impacts of the growing mass of retired LLINs from various LLIN campaigns. The Ministry of the Environment considered this a national priority and asked for assistance from the Quick Start Programme (QSP) trust fund of the Strategic Approach to International Chemicals Management (SAICM). The ministries also welcomed potential solutions proposed by the USAID mission in Madagascar since one of the main activities



Two women sit with their new LLIN that was hung up during the distribution campaign.

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under the President's Malaria Initiative (PMI) in Madagascar is to procure and distribute additional LLINs for future campaigns.

A stakeholders' meeting was held in Antananarivo in February 2010 to discuss lessons learned and best practices from the 2007 distribution campaign. Using the lessons learned, stakeholder participants discussed initial planning strategies, methodology, training, micro-planning, and census taking for the November 2010 phase of the nationwide rolling distribution campaign that had commenced in November 2009. Based on the decisions from this meeting, the LLIN recycling pilot project could be adapted into Madagascar's distribution strategy and incorporated into the 2010 distribution campaign, during which approximately 1.8 million LLINs would be distributed in the targeted districts.

A further opportunity for collaboration/ synergy was also identified. The SAICM QSP project was implementing an LLIN *Take Back and Recycling Study* and they were interested in partnering with the USAID | DELIVER PROJECT for the recycling pilot project. WHO was the implementing partner for the QSP project, with The United Nations Environment Programme (UNEP) providing technical support for reuse and waste-related issues. These studies were planned for the five districts with a history of LLIN usage/distribution. A joint steering committee, with the participation of the USAID | DELIVER PROJECT and PMI was established to coordinate efforts, promote collaboration and share findings.



November 2010 Distribution Campaign.

SAICM QSP Meeting

In March 2010, a SAICM QSP Inception Meeting was held in Antananarivo to discuss opportunities for collaboration between the 2010 LLIN distribution and the LLIN Recycling Pilot project, and to propose methodologies for the study's implementation and next steps. The meeting included more than 40 participants from the Malagasy Ministries of Health and the Environment; representatives from UNEP and WHO; bilateral donors from the European Union (EU), USAID, specialized technical agencies – such as the Centers for Disease Control (CDC), and the Institute Pasteur, and national and international non-governmental organizations (NGOs) (particularly the Malagasy Red Cross). In addition, private-sector partners were present, including representatives from LLIN manufacturers, the local plastics industry, and a toxic waste specialist interested in expanding his enterprise into recycling plastics.

The inception meeting introduced participants to the study and reviewed the social aspects that are essential to understanding usage patterns and the possible dangers associated with retired LLINs. Discussions were conducted on ways to determine the need, optimal timing, best modalities for retired LLINs retrieval, and the mechanisms, logistics, and related issues for collecting LLINs. General presentations gave an overview of environmentally safe waste management options for retired LLINs, which the group then discussed. The meeting concluded by reaching a consensus on the roles and responsibilities for the advancement of the two projects, as well as determining a potential location for the pilot. In particular, a close programmatic partnership between the two thematically related recycling-reuse activities in Madagascar was established, with the following

division of labor: the WHO-QSP would focus mainly on problem assessment and analysis concerning retired LLINs (including social, logistics and technical components), while the USAID | DELIVER PROJECT would be responsible for exploring the various options for collection and recycling of retired LLINs.

Based on field findings during phase I and consultations with the LLIN campaign coordination committee members, the steering committee felt that the net collection would be most successful if conducted in conjunction with the LLIN distribution campaign. This was deemed possible, given that a universal coverage campaign was planned for November 2010 and retired net collection activities could ideally be coordinated during the campaign.

Feasibility Analysis/Data Collection

In March 2010, following the SAICM QSP meeting, teams made up of staff from the USAID | DELIVER PROJECT and partners from SAICM and the NMCP traveled to districts in the 2010 distribution target areas to conduct focus group sessions and individual assessment surveys. Focus groups were conducted at the community level with the objective of trying to better understand the level of knowledge of local community members of the LLIN lifecycle, and to gauge their willingness to give up retired nets.

The focus groups consisted of community leaders, community health workers (CHW), other local leaders (religious, social, etc.), and at least 50 percent representation from local community members. A non-probability sample of households (in communities where the focus groups were conducted) was selected for individual household assessment surveys. Much like the focus groups, questionnaires were also administered to potential LLIN recipients (women, heads of households, etc.) to gauge the feasibility of an LLIN take-back campaign (i.e., were there enough retired LLINs available and were people willing to exchange them for new LLINs) (see appendix A). The teams targeted communities located near the health districts and along the main roadways, which facilitated the reverse logistics of the collected LLINs.

In addition to collecting the above information, the joint NMCP, SAICM, USAID | DELIVER team assessed regional site accessibility and transportation routes that could potentially be used for the collection of retired LLINs in the districts of Betafo, Taolagnaro, Toliara I and Toliara II.

Focus Group and Individual Survey Results from the Feasibility Analysis/Data Collection

A total of twelve focus group sessions, and 52 individual surveys were conducted in four districts (Betafo, Taolagnaro, Toliara I and Toliaria II). A convenience sample of 12 sites was used for the focus groups. Each focus group had 15 participants on average (both male and female). The data collected from the focus groups indicated that the participants' knowledge regarding the lifespan of LLINs varied (it ranged from one month – five years), as well as their understanding of when an LLIN could be retired (the top three responses provided were: when there are many holes, when the insecticide is expired, and when it is torn). It was



The survey team conducting a focus group session.

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discovered that there is a tendency among households to save old LLINs in the house or to repurpose them for domestic use (as curtains, pillows, blankets, fishing nets etc.). Participants did not indicate any potential blockages in returning their old LLINs, provided that they could be exchanged for new LLINs. From the perspective of the focus group participants, it was noted that one of the most effective ways to communicate about the collection campaign might be through health facilities, community health workers and agents, and local authorities.

In addition to the focus groups, 52 individuals were selected to participate in a 22 question survey. 77 percent of the participants were women and 23 percent were men. Convenience sampling was also used to identify these individuals. The results of the surveys indicated that there was an average of two LLINs per household, but in only 55 percent of the households surveyed did the entire family sleep under nets. Survey participants also indicated the likelihood of expired LLINs being used for a number of alternative purposes. 50 percent of participants believed that old or expired LLINs can harm the environment.

The survey results yielded positive news about the feasibility of conducting a collection campaign. Roughly 47/52 (90 percent) of respondents interviewed reported they would be willing to exchange their older LLINs for new LLINs, and 44/52 (84 percent) indicated that they would exchange the LLINs without compensation. These preliminary findings suggested the pilot project would be feasible (see appendix A for the complete results of the focus groups and questionnaires).

Site Selection

Based on the above information gathered from the feasibility analysis, and from historical data from previous net distribution campaigns, some potential sites were identified for the LLIN collection project. However, nothing was definitively decided upon.

Port Visit

Fort Dauphin, the deepest port found at the southeastern tip of Madagascar, was chosen as the consolidation point and port from which the LLINs would be shipped. The port was selected because of its proximity to the target districts, and because it had two 1,000 m² warehouses available for sorting, baling, and preparing the collected LLINs for shipment. In addition, the port can receive large vessels, has its own water and electricity systems, and meets the international security standards of International Ship and Port Security (ISPS). Critical infrastructure requirements, such as compacting capability and transportation, were also identified in preparation for the collection phase and were found to be adequate in the area around the port in Berenty.

Recycling Options

An initial recycling option for the collected LLINs considered by the project was incineration. To this end, two local alternatives were considered – the Holcim Cement Factory outside Antsirabe and the Adonis Waste Management Plant near Antananavario. However, at the time of visiting these facilities, it was determined that neither had sufficient capacity or infrastructure to incinerate large quantities of collected LLINs at the minimum required temperature of 1,200°C.

Finally, it was decided to use an external company to recycle the collected LLINs. The USAID | DELIVER PROJECT had already identified a U.S.-based plastics recycling firm, Trex, that was interested in a potential public-private partnership to recycle retired LLINs. Trex later agreed to support the pilot effort by paying to transport the collected LLINs from Madagascar to the United

States for recycling at its facility. Trex plans to perform a chemical content analysis of the plastic to determine the content of residual insecticide and guide them in determining the best possible recycled plastics options.

Phase I Conclusions

Based on the data obtained from the preliminary research phase, the prevalence of LLINs throughout most communities, the likelihood of LLIN return and the availability of suitable infrastructure, it was agreed that Madagascar was a feasible option for the implementation of Phase II of the pilot project. In-country stakeholders in Madagascar, PMI and USAID/Madagascar approved the project to proceed to Phase II of the pilot in selected southern districts.

Phase II – Collection Methodology

Phase II consisted of five steps including: 1) planning, design and development of the collection strategy; 2) designing and implementing a communication strategy; 3) site selection; 4) contracting and; 5) physical collection of the nets. Each step is detailed below.

- **Planning, Design and Development of the Collection Strategy** – in this initial stage, project considerations included forecasting, logistics, budgeting, local consensus building, coordination with the LLIN distribution campaign, and organizing workshop dates.
- **Designing and Implementing a Communication Strategy** – the project team developed and disseminated behavior change communication/information, education, and communication (BCC/IEC) materials to community workers and local leaders who were subsequently trained to raise awareness in their communities and carry out the LN recycling campaign.
- **Site Selection** – the final collection districts were selected.
- **Contracting** – A contractor was selected for the distribution of new LLINs and the collection of retired LLINs (CLR); another contractor (Prorent) was identified to compact the LLINs and transport them to the port by truck, and Trex – a U.S.-based plastics recycling company – was identified to transport the nets by boat from the port in Madagascar to their recycling facility in the United States
- **Collection** - retired LLINs from the six districts were collected, sorted, compacted and transported to the port for shipping.

Planning, Design and Development of the Collection Strategy

In planning for the actual collection of retired LLINs, the project considered each of the following key operational questions:

1. How could we forecast the potential quantity of retired LLINs to be collected?

In order to estimate the potential number of LLINs that could be collected in the six selected pilot districts, the project used two primary data sources: data collected in the feasibility analysis during Phase I (see results discussed previously), and a post-2009 universal campaign evaluation which included questions on willingness to give up expired nets (CDC, 2010).

As mentioned in Phase I, among a small non-probability sample of individuals surveyed, 47/52 (90 percent) said that they would be willing to give up their expired net if they were to receive a new net. In the post-campaign evaluation, among 2,211 households surveyed, 471 (43 percent) indicated that they owned a net that they no longer used for sleeping. These results provided an initial indication of the potential return rate that could be expected for the collection campaign.

For planning purposes, the project team set a target equal to 30 percent of the total number of LLINs distributed to these districts during the 2007 campaign for the recycling pilot. This represented approximately 77,000 retired LLINs.

2. What other factors should be considered for setting the target for the number of LLINs to be collected?

Based on a full production cycle, Trex indicated that their ideal number was approximately 60,000 retired LLINs, with half being Olyset (high-density polyethylene) and the other half Permanet (polyester). Comparing the lowest percentage of households indicating they would give back a retired LLIN with the figure of 279,000 LLINs distributed in 2007, there would still theoretically be enough retired LLINs to meet Trex's requirements. The target, therefore, was not based on a separate forecast, but on the research phase and the objective set by Trex.

3. How could the level of resources required to collect retired LLINs be assessed and a budget for the Give-Back Campaign be established?

The LLIN distribution campaign was used as a model to develop the budget for the collection phase. Similar to the mass distribution campaign, district level stakeholder workshops and a training module was developed. The training module was added on to the mass distribution campaign training module for the six targeted districts. The logistics of the collection phase was designed similar to the LLIN distribution campaign but in reverse.

For example, the distribution sites used during the distribution campaign were identified as potential sites to collect and store the retired LLINs during the collection campaign. The community leaders who were involved in the distribution campaign were also involved in the collection campaign. Finally, the distribution campaign also influenced, to some extent, the selection of vendors for the collection of retired LLINs – as those vendors who participated in the distribution would be able to offer more competitive prices for various components of the collection campaign.

4. How could the collection of retired LLINs be facilitated, given all of the unknown factors?

Logistically and economically, it was shown that there were clear benefits to the project by combining the collection phase with the distribution campaign – including the support of the local population, the optimization of resources and potentially lower costs. It was initially planned to use the distribution campaign network to collect, gather, and transport the retired LLINs to a central location, while establishing a system flexible enough to meet last-minute demands.

However, in practice, most of the collection occurred during the immediate post-campaign period, instead of at the same time as the LLIN distribution. This was due to the fact that negotiations with our subcontractor, PSI, did not begin until November. It was also the first time that distribution had been subcontracted to a local NGO (CLR), and CLR had no prior experience with conducting LLIN distribution campaigns since the previous campaigns were managed by the NMCP. Global Fund requested that a local NGO be contracted rather than the NMCP in order to create a more transparent process. This created a delay of the campaign by several months, and led to extra work and time needed to collect the nets.

Although several of the organizers, contractors and participants were the same, the two campaigns were eventually handled separately. Each campaign had its own budget, its own communication and awareness strategies, and its own vendor selection process.

5. What incentives could be offered to increase the likelihood of collecting a large number of LLINs?

It is our belief that the success of the collection phase, and the overall success of a recycling project, first depends on educating partners, local leaders and the population about the possible environmental and health concerns associated with keeping in use or improperly disposing of an LLIN after it has been retired. As such, BCC/IEC materials were developed as part of the project's communication strategy to enable local partners to inform the population about the collection campaign.

Aside from developing a communication strategy, the project and stakeholders decided that the best incentive to encourage users to give back their retired LLINs was to facilitate an easy exchange by linking the free mass distribution campaign with the collection campaign – essentially to collect the retired LLIN and replace it with a new LLIN right away. While the project needed to capitalize on the distribution campaign to maximize the collection of retired LLINs, a key concern was to ensure that community members, would under no circumstance, be made to think that they had to return an older LLIN if they wanted to receive a new LLIN. Training and IEC was designed to reinforce the voluntary nature of the collection.

As mentioned above, this ultimately did not happen, but it is our recommendation to combine the two campaigns for others who wish to implement similar recycling projects in other countries.

6. How could we explain the purpose of the campaign to the local population?

The project decided that both verbal communication and a visual support would be the best means through which to explain the recycling campaign.

The communication campaign was based on two key concepts:

- After LLINs have been used for many years, they no longer protect people from malaria;
- Retired LLINs may present risks to the environment. Fortunately, much of the population already seemed to be sensitive to environmental factors – something that was confirmed by the results of the phase I feasibility analysis/data collection (see appendix A).

7. How could we inform the largest number of households about the collection campaign, before the distribution campaign? What are the most effective tools to use?

Prior to the beginning of the distribution campaign, the project launched a training/awareness program in each of the six targeted districts. Project representatives met with local mayors, fokontany chiefs, health representatives, and community workers.

Ideally, IEC material development would be coordinated with that of the main distribution campaign. The project contracted a local communication specialist to develop a marketing message explaining the collection campaign at the household level and to create an informational job aid for community volunteers to use (see figures 3 and 4) which was also approved by the campaign coordination committee IEC subcommittee.

The job aid was included in the supplementary training module and used during the main campaign training. The project coordinated the logistics of distributing the job aid with PSI so that the materials were available to community volunteers prior to the campaign.

The project decided not to use radio messages, as we were unsure of the impact in rural areas, especially in the target area. Furthermore, as the pilot was focused in only six districts in the south,

the project did not want to broadcast a message that would travel beyond the targeted region. It was also unclear whether local radio stations were available and able to respond to our specific coverage needs.

8. How could we gain momentum after the project started?

Detailed planning of the awareness, training, and communication campaigns was critical to generating momentum, particularly as a result of working with a limited budget. The project organized workshops when the campaign started for consensus building and awareness raising with community leaders and community workers, sharing key messages with them while encouraging and gathering their comments and suggestions.

Communication Strategy Development and Implementation

Partners developed survey materials and had them translated into Malagasy. The materials were also field-tested and approved by the campaign IEC committee prior to dissemination. The discussions/questions concentrated on the BCC/IEC approach to use when collecting retired LLINs.

The project partners collaborated with local authorities, including mayors and fokontany chiefs, to build consensus and gain acceptance and support from the local communities. The local authorities contributed significantly to the implementation of the pilot project, in terms of advocacy, awareness raising and organization.

Advocacy Among the Health Sector

Since the activity is within the scope of LLIN management, which is part of the National Malaria Control Program, it was necessary to introduce the project and advocate for it with the health staff at the six target districts. Due to the United States Government's (USG) restrictions on Madagascar, the USAID | DELIVER PROJECT was not able to pay per diems to district health staff who attended workshops; as a result the project had to take another approach and instead held an advocacy day at the district level to introduce the pilot concept and methodology.

Orientation Workshop

The project held two successive workshops in August 2010 and in September 2010 to inform the mayors of the 102 communes from the target districts about the implementation of the pilot project and also to share critical information. Including the mayors in BCC/IEC was a successful strategy for the activity. Following the workshop, the mayors organized meetings with their fokontany chiefs to transmit the messages and to share the information received during the workshop.

The various topics discussed during the workshop included—

- review of the National Malaria Control Program strategies and presentation of the pilot project
- achievements and the workshops and trainings organized
- general organization of the pilot project
- key messages and the job aid for the community workers.

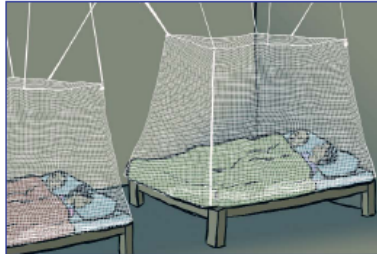
Designing and Developing BCC/IEC Messages and Materials

The primary audience for the information campaign was community workers and fokontany chiefs. The project prepared a job aid (see figures 3 and 4 below) for them to use to help them inform households about the LLIN recycling campaign.

Figure 1. BCC/IEC Materials (Job Aid)

Ny tokony hampiasana ny lay misy ody moka maharitra


Natao hatoriana isak'alina ary mandavantaona ny lay misy ody moka maharitra.




Miaro ny ankoahorantsika amin'ny aretina mifindra amin'ny alalan'ny kaikitry ny moka, indrindra fa ny Tazomoka izany.

Ahoana no iarovan'ny lay misy ody antsika ?


Misakana ny moka ny lay misy ody maharitra ao anatin'ny telo taona



Mampandositra ny moka ny ody moka maharitra eo amin'ny lay




Mamono ny moka ny ody moka maharitra eo amin'ny lay



AVERENO NY LAY
EFA TSY ILAINA SY TSY MANDAITRA INTSONY

Araraoty ny Fizaràna Faobe Lay misy ody moka maharitra izay hatao alohan'ny faran'ny taona : eady mamerina ny lay tsy mandaitra intsony isika no hahazo lay vaovao indray!!



TONGAVA MAKA LAY
MISY ODY MOKA MAHARITRA VAOVAO





Figure 1 translation: (from top left): How to use a long-lasting insecticide-treated bed net. Sleep under an insecticide-treated bed net every night throughout the year. It protects our family from mosquito-borne diseases, especially malaria. How does an insecticide-treated bed net protect us? It prevents mosquitoes from reaching us for three years. The insecticide in the bed net repels mosquitoes. The insecticide in the bed net kills mosquitoes.

(from top right): Bring back the bed nets that are no longer used or are ineffective. Take advantage of the mass distribution of long-lasting insecticide-treated bed nets before the end of the year: when you turn in an ineffective bed net, you will get a new one! Get your long-lasting insecticide-treated bed net.

Figure 2. BCC/IEC Materials (Job Aid)

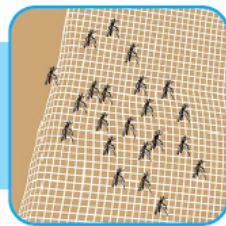
Tsy mandaitra ny lay rehefa :

► ROVITRA




► EFA NIHOATRA NY Telo TAONA :

- tsy mampandositra
- na mamono ny moka Intsony




► TSY LAINA INTSONY.




Tandrovy ny tontolo iainana !!

Tsy azo ampiasaina amin'ny jono, na ny fambolena, na ny fiompiana izy ireo satria ny eisam-panafody tavela aminy dia mbola manimba ny tontolo iainana



Tsy izany koa ny antony tsy tokony handoroana na hanariana azy eny rehetra eny.



Ny lay misy ody moka maharitra dia natao hiadiana amin'ny tazo moka irery ihany.




Figure 2 translation: (from top left): A bed net is ineffective when: it is torn or has holes; it has been used for more than three years—it no longer repels mosquitoes, it no longer kills mosquitoes; it has become useless.

(from top right): Take care of the environment! Bed nets must not be used for fishing, cultivation or animal farming; the insecticide left in them is still harmful to the environment. For the same reason, they must not be burned or disposed into the environment. Long-lasting insecticide-treated bed nets are meant only to protect against malaria.

Training Community Workers

Cascade training was coordinated with the training organized for the distribution campaign:

- *Training-of-trainers (TOT) by MRC (the training provider):* The objective was to train local trainers so they could, in turn, train community workers and fokontany chiefs in the critical campaign messages and the organization of the LLIN collection campaign activities.
- *Training the community workers and fokontany chiefs:* This training was combined with training the community workers for the LLIN distribution campaign; it was included in the LLIN distribution campaign budget.

The training objective was to train community workers and fokontany chiefs in the project goals and their accompanying activities so they could organize and carry out the LLIN collection campaign

activities. It is important to note that community participation was critical for project success and implementation. These trainings helped ensure that participants and communities would be engaged at each level of the project.

Site Selection

Six districts in southern Madagascar were selected for the collection phase (Phase II) of the recycling pilot project. They are Betioky, Ampanihy, Beloha, Taolagnaro, Tsihombe, and Ambovombe (highlighted in the figure to the right).

These districts were ultimately selected because of the pervasiveness of malaria and the history of LLIN distribution campaigns throughout the region they were located in. In 2007, 279,000 LLIN had been distributed in this region. Furthermore, between 2007 and 2010, no additional LLIN distribution campaigns had occurred in this area and many of the LLINs from 2007 could potentially now have been retired, or be ready to be retired by their users.

These districts were also chosen based on the mixture of both polyester and polyethylene LLINs likely to be found in the area which would facilitate options for the testing of the plastic polymers for pesticide residue.

Some additional factors that influenced the selection of these districts were their proximity to an international seaport, an overlapping timeframe with the mass distribution campaign, and a recommendation from the LLIN coordination committee to use the region as a potential site. Additionally, the project found that there was political commitment and willingness of local authorities to support the project.

Contracting

The logistics complexity of the different tasks (collection, storage, transportation, sorting, compacting, and shipping) was reviewed and analyzed. Based on this assessment, the project decided to issue two Requests for Proposal (RFP).

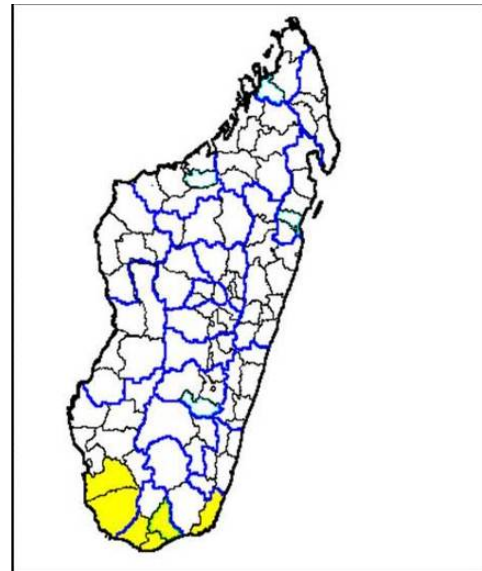
The first RFP was similar to the planned activities of the distribution campaign, except in reverse, and focused on the collection process at the local level, including three major steps:

1. collection of retired LLINs at the community level collection sites;
2. transportation of the retired LLINs to a central location at the district level;
3. storage of the retired LLINs at the district level.

It was expected that all the vendors who responded to the distribution campaign RFP for the southern region of Madagascar would also respond to this RFP.

Of the organizations who responded to the first RFP, Consortium Lova/Réssources Vertes (CLR), the same NGO that handled the distribution of the new LLINs in the southern region of

Figure 3. Six Districts Where the Collection Phase Took Place



Madagascar, was found to be the most competitive and was selected. CLR decided to use almost the same network and organization they had used for the distribution campaign. For example, CLR planned to use the same sites for the collection campaign that they had used for the distribution campaign.

Since it was difficult to forecast the number of retired LLINs that could be collected, and it would be difficult to monitor the level of resources that CLR would dedicate to the project, the RFP was written with a variable cost structure. This structure was designed to provide a strong incentive for CLR to collect as many retired LLINs as people were willing to give up, since the more retired LLINs that CLR collected, the higher their compensation would potentially be. At the same time, this type of cost structure would limit the amount to be disbursed if only a limited number of retired LLINs were collected.

The second RFP focused on compacting and preparing the collected LLINs for shipping via sea freight. It combined the following seven steps:

1. transportation of the retired LLINs from the district level to a central location where they would be compacted;
2. sorting of the collected LLINs at the central location according to polymer type and degree of cleanliness;
3. compacting the sorted, collected LLINs into bales;
4. storing the bales;
5. transporting the bales to the port;
6. packing the containers at the port;
7. loading the containers on the vessel. (see figure 2)

Similar to the first RFP, the pricing structure was based on variable costs to limit the project's contractual risk in the event that the contractor only collected a small number of retired LLINs.

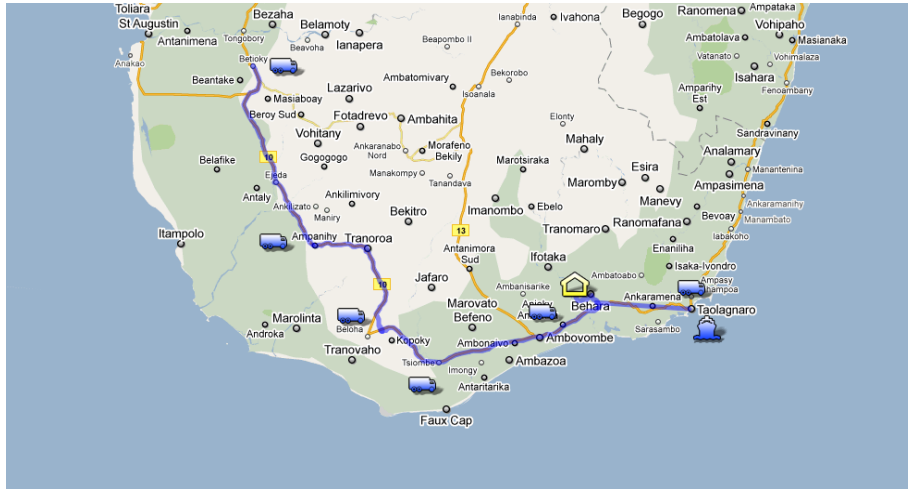
Used, unpackaged LLINs are bulky; therefore in order to transport them in the most cost-effective manner, they must be compacted. While the project did not expect any difficulty in finding a qualified trucking/logistics company to transport, sort, and store the collected LLINs, there was concern regarding the identification of vendors capable of compacting the collected LLINs. Several options were considered including shipping a compactor to Madagascar.

The technical capabilities of small individual compactors were also assessed, but were found to be inadequate for compacting large quantities of old LLINs within the timeframe of the pilot. After further investigation with local partners, the project discovered that the sisal industry in the south of Madagascar uses powerful compactors to build large bales of fibers before they are exported. The project contracted with the sisal manufacturers to use their compactors.

Four vendors responded to the second RFP. After a review, Prorent, a sisal manufacturer located in Berenty (in the southeast of Madagascar) was selected. Prorent has its own fleet of vehicles, facilities, three large compactors, and is capable of stuffing 40-foot containers. Prorent is also a subcontractor for the World Food Programme and distributes rice in the southern region of Madagascar when food is scarce.

The costs for exporting, sea freight and importation in the US were borne by Trex and will be detailed in a separate report once Phase III of the pilot project is complete.

Figure 4. Collection Route, Compacting, and Shipping Points



Legend	1 inch = 60 km
Route = where the bed nets were collected in each district and eventually taken to be compacted and shipped	
Truck icon = pick-up points in each district	
House icon = compacting site	
Boat icon = Port Daubhin	

Collection

To facilitate the reverse logistics involved in collecting retired LLINs, the project took a number of steps:

1. The retired LLINs were collected at the community level in the six target districts;
2. The collected LLINs were transported to the six district warehouses and stored;
3. The LLINs were transported from the six district warehouses to the central warehouse in Berenty and sorted by plastic type (PET or HDPE).
4. The LLINs were compacted into bales and transported to the port where they were loaded onto a shipping container;
5. The LLINs were shipped from Fort Dauphin, Madagascar to Trex's facility in Virginia, USA.

Further details about the collection process can be found in the results section.

Phase II – Collection Results

A total of 22,559 retired LLINs (equal to more than 13 tons) were collected in the six districts of Betioky, Ambovombe, Tsihombe, Beloha, Taolagnaro and Ampanihy over a period of four weeks. This is compared to Trex’s original give-back target of 60,000 LLINs (based on a full production cycle), and the project’s initial target of 77,000 LLINs (based on 30 percent of the total number of LLINs distributed during the 2007 campaign). More detailed numbers are provided in table 4.

The personnel involved in the field operations (collection, staging and consolidation, materials preparation, etc.) used the best available technologies and followed the best environmental practices in handling the retired LLINs.

CLR, our contracted local NGO partner, with oversight from the project, moved the retired LLINs from the collection sites to the district level using numerous types of available transportation – including canoe, horseback, handcart, motorbike, oxen etc. These LLINs were consolidated and securely stored in six district warehouses in Betioky, Ampanihy, Tsihombe, Beloha, Ambovombe, and Taolagnaro.

Some considerations for the consolidation sites were as follows: they had to be reasonably accessible, have paved roads, have a secure area for consolidation points (i.e., warehouse space), have cell phone reception, and a trained consolidation site manager (literate in French). In addition to the consolidation site manager, a local supervisor was assigned by the USAID | DELIVER PROJECT to each district as a temporary representative to monitor and ensure the effective organization and routing of the collected LLINs to the compacting site in Berenty via the district warehouses.

Prorent, our contracted commercial sisal grower, provided transportation equipment to move the bulky collected LLINs to the central warehouse in Berenty. The trucks had to be covered to ensure safe and clean transportation for the collected LLINs.

Once at the warehouse, the site manager supervised the sorting of the used LLINs by plastic polymer type and polyester (PET) versus polyethylene (HDPE). In addition, the LLINs were sorted by how dirty they were, which varied significantly, depending on the exact collection site (areas with more access to water usually had cleaner LLINs). It was unnecessary to sort LLINs by color. The sorting was done in a 60 foot × 30 foot dedicated, secured warehouse. The nets were then compacted into 270 bales using a sisal press (pictured to the right).

The bales were loaded onto trucks and transported to the port at Fort Dauphin, where they were subsequently loaded into a single 40-foot shipping container for transport to Trex’s facility in the United States.



Sisal press used to compact LLINs.

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Phase II – Findings

Based on Phase II of the LN recycling pilot, we have identified a number of findings. It should be noted that the findings reported here are not, in any way, statistically significant, or representative of the population at large. Some findings, such as willingness to give back retired LLINs, is reflective of the perspectives of community members who were interviewed after the distribution campaign. A number of the findings discussed below merely provide points for further insight, or lessons learned for others who are considering recycling as an option for retired LLINs in their country. A detailed explanation of each finding is provided below.



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Women separating LLINs by plastic type at the central warehouse.

1. Reverse logistics is possible

Collecting retired LLINs for disposal or recycling at the community level is feasible in Madagascar.

2. Local infrastructure must be in place

The success of a collection campaign depends on critical infrastructure being in place – such as having available warehouses, transportation, a port from which to ship the nets (if they are going to be recycled outside of the country), and a compacter.

3. Logistics is easier when distribution and collection are combined

If combined, the same warehouses, vendors, trainings, and IEC/BCC materials can be used.

4. Savings could occur if distribution and collection are combined, however collection is still more expensive than distribution

Substantial savings could occur if distribution and collection are combined. Coordinating and combining pre-campaign activities for both the distribution campaign and the collection campaign would likely be cost-saving for the collection campaign. For example, training costs could be minimized if a single training had been conducted for the TOT trainings, rather than being conducted as two additional workshops. The estimated savings of the combined campaigns would be roughly 80 cents per net, which consists of training and IEC/BCC costs.

Despite the cost savings that would result from a combined distribution/collection campaign, the process of collecting retired LLINs is still more expensive than distributing new nets. In this pilot, it was nearly double the cost (see tables 1 and 2 below). This was not unexpected given the nature of a pilot project, and the unforeseen operational factors.

This is due to additional costs for sorting and compacting, and for the additional trucks required to transport the nets at each level - since the volume of retired versus new nets is greater. There are also other variable costs that have an impact on final cost including: translation (of all materials used), printing, the number of trainings offered, and the number of trucks needed (which is based on the estimated size of the nets collected).

When conducting a collection campaign for the first time it can be a bit difficult to assess the resources needed and this will also vary by country. However, an important lesson learned is that the RFPs should include variable rather than fixed costs due to the difficulty in forecasting the number of nets that will be collected.

Table 1. Total Distribution Cost per LLIN During Mass Distribution Campaign (NMCP/PSI)*

	Cost	Percentage of overall cost
Transport to district level	\$0.12	9%
Transport to site level	\$0.14	10%
Other costs (this includes training and IEC/BCC)	\$1.09	81%
Total cost per net	\$1.35	100%

*This cost of \$1.35 per LLIN includes in-country costs only. It does not include the cost of purchasing the LLIN. Additionally, the project was not involved in the physical distribution of the nets, and for purposes of the pilot these figures were not further analyzed.

Table 2. Total Collection Cost per LLIN

	Cost	Percentage of overall cost
Collection from sites, and transport to districts (CLR)	\$1.19	44%
Transport from district to port, and compacting (Prorent)	\$0.30	11%
IEC/BCC	\$0.13	5%
Training costs (including awareness raising/consensus building)	\$1.10	40%
Total cost per net	\$2.72 *	100%

* The total collection cost per net is \$5.44 if we account for both the cost of the activity and the overhead. Of the total cost of the pilot, 52percent of that amount was the activity cost (as depicted in table 6 above) and 48percent was the program cost.

5. The success of a campaign is dependent on the population’s willingness to give-back retired LLINs

The success of a collection campaign is strongly determined by the population’s willingness to give-back their retired LLINs. Additionally, their participation is contingent on a number of factors (as outlined in table 3 below). Much of the data that was collected on willingness to participate in a collection campaign is either based on anecdotal observation by the project, or on the perspectives of individual community members who were surveyed during the post-campaign period. These findings are therefore not representative of the population at large, or statistically significant in any way. Additionally, given the time limitations and the sample size for the survey, we cannot say conclusively that these are all of the reasons for lack of participation in the collection campaign. However, these findings do provide some insight into potential reasons why people were or were not willing to give back their retired LLINs (further explanations are provided below for the asterisked points).

Table 3. Willingness to Give Back Retired LLINs

Factors that influenced people’s willingness to give back their retired LLIN(s) (based on post-campaign survey)
1. Whether there were enough nets to give back* (i.e. some had not received an LLIN in the previous distribution, or had not received enough to provide coverage for everyone in the household and as such were not ready to give up their old LLIN).
2. Whether a new net had already been received and installed in the household
3. Did not currently own an old LLIN (either they never owned an LLIN or they had previously discarded or disposed of it)
4. Gave their old LLIN(s) to family members who did not receive LLINs during the distribution campaign
5. Had paid for the old LLIN, so they did not want to give it back for free
6. Another donor (i.e., the Red Cross) gave them their old LLIN(s), so they did not understand why they should give it to USAID
7. Thought they should receive financial compensation to give back the retired LLIN(s) (When they heard that there was an interest in collecting retired LLIN, they began to think that, contrary to what they had always thought, the older LLINs had some financial value)
8. They thought their retired LLIN(s) was/were too dirty to be reused
9. Did not want to give back something that has protected them from malaria

10. Wanted to keep the old net for use and sell the new net

11. Were re-using the retired LLIN for alternative purposes, such as—

- fishing
- rope
- blankets
- shower curtains
- tent for kids
- perimeter around the house
- cover or transport their crops
- make wedding dresses
- stuff or cover mattresses

12. Income*

The data in the table above were collected from impromptu interviews conducted during the post-distribution campaign. Very few retired LLINs were exchanged for new LLINs during the distribution campaign, and as a result the collection supervision team wanted to explore potential reasons why people were or were not willing to give up their old nets. A non-probability sample of community leaders and community members were interviewed immediately after the main campaign in the two villages of Andramaka and Ambinanibe in the district of Taolagnaro.

Fifteen interviews were conducted in each village (for a total of 30 interviews). The following questions were asked to identify reasons that might be related to participation in the recycling campaign:

- Question 1. What is the number of people in the household?
- Question 2. What is the number of LLINs required?
- Question 3. What was the number of LLINs received?
- Question 4. Was/were the new LLIN(s) already installed?
- Question 5. Was the household aware of the give-back campaign?
- Question 6. If you didn't exchange your retired LLIN for a new LLIN during the campaign would you still give back your old LLIN in the future?

While there were numerous reasons cited for not wanting to give back retired LLINs, in this particular situation it appears that there was a strong correlation between the number of nets distributed and willingness to return old nets.

In Madagascar, the number of LLINs distributed to the population was based on a ratio of one LLIN for every 2.56 inhabitants. The free mass campaign distribution goal was 1 LLIN per 1-3 persons, 2 LLINs per 4-6 persons, 3 LLINs per 7-9 persons, etc. Several households that were interviewed reported receiving fewer LLINs during the distribution campaign than they should have based on the campaign guidelines. Among the households that did not receive the correct number of LLINs, several reported that this was the main reason why they would not give up their old LLINs (because they did not have enough new nets to protect their family).

In addition, it is possible that even among households that received the correct number of LLINs, that there may not be enough to adequately cover the family based on sleeping patterns in the household. For example, if a couple has a child that is ten years of age or older, the child may not sleep in the same sleeping space as the parents. In this scenario, two LLINs would be required to adequately cover the sleeping spaces that the family uses. The data collected with this convenience sample of households indicate that households without enough nets to cover all family members were unlikely to participate in a recycling campaign. It is likely, therefore, that the success and results of a distribution campaign is likely to have a direct effect on the success of a recycling campaign.

***Income versus retired LLINs collected**

A non-probability sample of households was visited during supervision to explore other factors that might be related to household members giving up their old nets. The houses ranged from very modest huts to larger wooden structures. Based on these observations, the households with a slightly higher income were more likely to participate in the give-back campaign than households with a lower income. This seemed to be a result of the fact that households with a higher income did not attach a monetary value to their older LLIN as much as the households with a lower income. However, there is no conclusive evidence of this.¹

6. Distance and limited access to roads inhibit collection efforts

From the perspective of local contractors and supervisors, distance and poor access to roads were key obstacles in trying to visit some of the collection sites (difficulties that were increased due to the rainy season). For example, some sites required multiple methods of transport including carts, canoes, and manual transport. Not only are these methods more logistically complex, but they are also more time consuming. It is likely that these factors increased the difficulty of reaching remote sites.

The project, therefore, did not collect from all the potential collection sites. In Beloha, for example, only 39% of the collection sites were visited. However, had all the sites been visited (also assuming that the sites not visited would have given back in the same proportion as the sites that were visited), only one district (Beloha) would have reached and even outscored its target. The total number of used nets collected would have increased from 22,559 to 30,229. Yet, the original target of 60,000 nets still would not have been achieved (see table 4 below).

Distance and poor access to roads should be taken into consideration for any future recycling campaigns. It may be possible to promote collection efforts in easier-to-access distribution centers while promoting safe re-use or alternative collection systems in remote and hard to reach areas.

7. There is no correlation between population size, density, area and LLINs collected

Population per district versus retired LLINs collected per district

Our pilot indicated no direct correlation between the size of the population of a district and the number of retired LLINs collected. In Ambovombe, the most populated of all the districts with

¹ This was based on anecdotal observation by the project team.

529,143 inhabitants, 3,900 retired LLINs were collected. In Beloha, a district with a population of 111,235, a total of 1,866 retired LLINs were collected. Although Beloha's population represents only 20 percent of Ambovombe's population, the number of retired LLINs collected in Beloha represents almost half of the retired LLINs collected in Ambovombe.

Additionally, the largest number of retired LLINs was collected in Betioky, despite the fact that it has the third smallest population of the six districts. Therefore, it can be said that the number of retired LLINs collected is related to the number of LLINs that are actually present in the communities.

Population per collection site versus retired LLINs collected

Betioky also had the largest number of LLINs collected at a single collection site (752), although this collection site did not have the largest population at that site (see table 5). Of all the districts, Ambovombe consistently collected the lowest number of retired LLINs; this district collected the smallest number of retired LLINs at a single collection site—seven—although it has the largest population at that collection site (5,210 inhabitants). Ampanihy, conversely, had the smallest population at that collection site (974), but the number of LLINs collected (40) was more than five times greater than what was collected in Ambovombe (table 5).

Initially, the project tried to determine whether more retired LLINs could be collected from sites with a larger population than those with a smaller population. The project thought that the larger the collection site, the more likely it was that a large number of retired LLINs would be collected. However, we were told that larger FKTs were often less likely to give back their retired LLINs than those living in more rural areas – who are more likely to listen to the chief FKT's recommendations.

In only two districts did the largest population size also had the largest number of retired LLINs collected—Beloha and Betioky (see table 5). Also worth noting is that the smallest number of retired LLINs collected per collection site in Ampanihy was 40. In the five other districts, this figure is equal to, or smaller than, 15. After reviewing the project team's report in Ampanihy, it was noticed that the local NGO representative asked all collection site managers to collect at least 40 used LLINs. While the project did not set a minimum number of retired LLINs to be collected, it could be useful to evaluate the impact of such a strategy for future campaigns.

Table 4. Population Size, Number of LLINs Distributed and Collected, and # of Collection Sites Visited

Districts	Estimated Population per District	Number of LLINs Distributed in 2007 Campaign	Number of LLINs Distributed in 2010 Campaign	Total LLINs Collected	Total Collection Sites in Each District	Total # Collection Sites Where LLINs Were Collected	Total Collection Sites Where LLINs Were Collected (As a Percentage)	Potential # of LLINs that would have been collected if all sites had been visited
Betioky	209,810	44,100	81,754	8,143	120	100	83%	9,772
Ampanihy	353,594	53,480	137,748	4,607	103	71	69%	6,683
Tsihombe	131,495	17,300	51,226	803	41	41	100%	803
Beloha	111,235	17,000	43,333	1,866	33	13	39%	4,737
Ambovombe	529,143	68,050	206,136	3,900	105	82	78%	4,994
Taolagnaro	321,152	59,500	125,110	3,240	87	87	100%	3,240
Total	1,656,429	259,430	645,307	22,559	489	394	81%	30,229

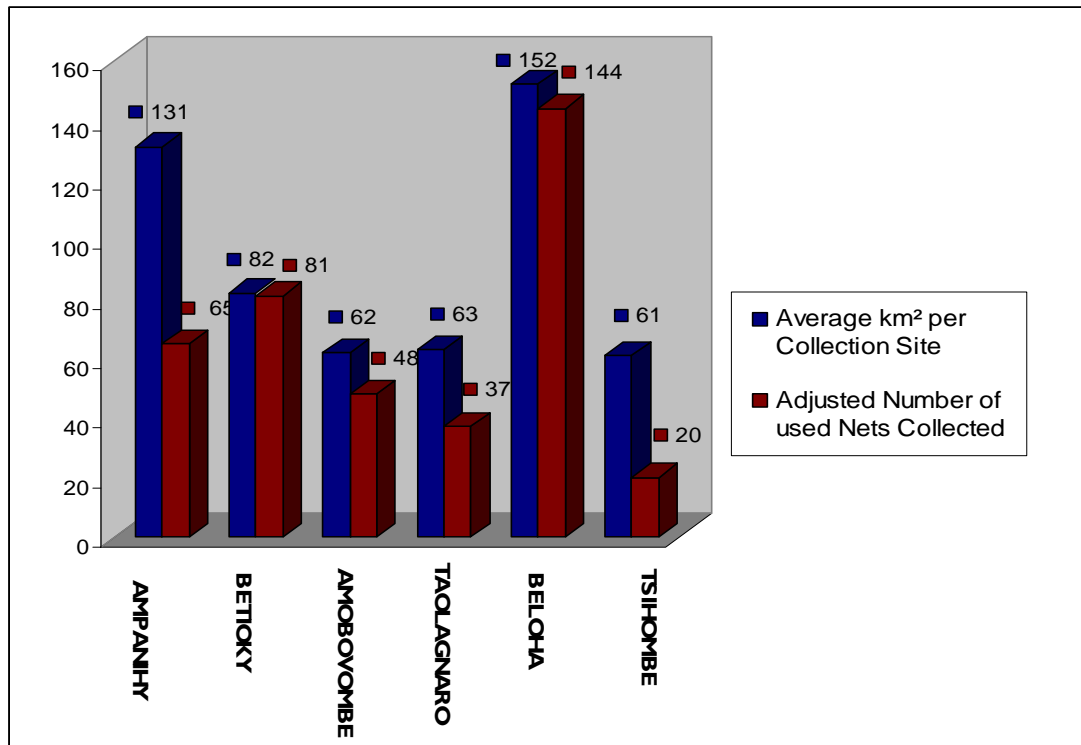
Table 5. # of LLINs Collected at Collection Site with Largest Population

	Collection Site with the Largest Population	Retired LLINs Collected in this Collection Site
Taolagnaro	15,736	35
Tsihombe	10,764	23
Ambovombe	8,165	37
Beloha	6,060	421
Betioky	4,990	752
Ampanihy	3,449	41

Size of a collection site (average area) versus retired LLINs collected (adjusted to 100 percent)

Based on the results from the pilot, we found that the partition and concentration of the population, rather than average size of a collection site, were the primary determinants of the adjusted number of retired LLINs collected per collection site. However, these two parameters were not taken into account in the analysis (see figure 5 below).

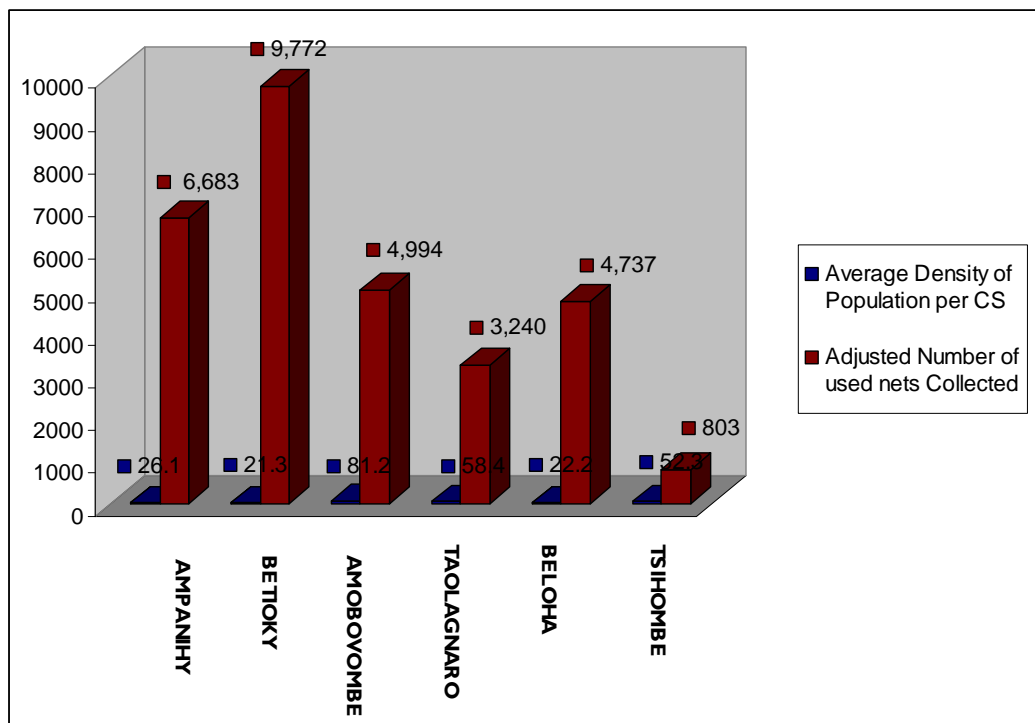
Figure 5. Average Area (km²) per Collection Site Compared with Adjusted # of LLINs Collected



Concentration of population versus retired LLINs (adjusted to 100 percent)

Paradoxically, the largest number of retired LLINs collected was from the region with the smallest population density per collection site (Betioky). The region with the highest population density (Ambovombe) was third in terms of overall number of LLINs collected (if 100 percent of the collection sites had been visited). See figure 5.

Figure 6. Average Density of Population per Collection Site vs. Adjusted # of LLINs Collected



8. Communication strategies may improve the success of a collection campaign

There are numerous communication strategies that may improve the success of a collection campaign, such as the following:

Ensure that message dissemination is timed appropriately.

It is important that message dissemination be timed closely with the distribution campaign so that the recycling campaign does not lose momentum. If too much time lapses between the recycling communication campaign and the start of the distribution campaign, the chief FKTs and the households forget the purpose of the collection campaign. Our communication campaign lost some of its momentum because the distribution campaign was postponed by two months.

Additionally, if IEC surrounding give-back does not occur in tandem with door-to-door distribution (unlike in Madagascar), perhaps even fewer nets than expected will be collected back. The ideal timing of house to house communication about voluntary retired LLIN collection activities is still to be determined.

Additionally, based on anecdotal observation, it is recommended to schedule the recycling campaign so that it is not conflicting with any other health programming so that the population can prioritize the collection activities.

Use verbal communication as well as visual tools.

Both verbal communication and a visual support may be the best tools to explain the recycling campaign where rates of literacy are either unknown or known to be poor.

Share messages about the “recycling value” of LLINs.

Increasing awareness before a distribution campaign by sharing messages about the *recycling value* of LLINs is critical to any future efforts. Because this effort can be very costly, it should be incorporated into the strategy of the overall distribution effort, and in densely populated areas of the country, in particular, to obtain maximum return.

The IEC messages for the recycling pilot were designed to be simple, clear, and related strongly to the targeted audience. They emphasized two key reasons for the recycling campaign: (1) LLINs are not effective after a few years and need to be replaced; and (2) retired LLINs can represent a hazard to the environment and should be disposed of in a well-organized way.

In addition, CLR developed some interesting ideas about the additional messages that could be used to encourage the population to participate in the give-back campaign. For example, the representative of the Ambovombe district mentioned that the south of Madagascar was known to be the region where projects start but are always abandoned—it is known as *a cemetery for projects*. As a result, CLR told the local population that if they wanted to keep USAID’s support, people had to demonstrate that (1) they were still using the LLINs that were distributed to them in 2007, but that (2) that these were now too old and had to be replaced. By giving back their retired LLIN, people had a unique opportunity to keep the program going.

Use the radio as a communication tool, in areas where it is available.

After the main distribution campaign, CLR suggested that the radio would be an effective way to communicate messages about the recycling campaign. These broadcast on radio stations in some of the pilot districts.

An assessment of local radio network coverage and use would be a worthwhile activity in planning and prioritizing both distribution and collection campaign IEC activities in the future. If local radio channels are available they can be effective at diffusing messages in targeted and remote areas.

9. Increasing local ownership may result in more nets being collected

It was observed that a greater number of LLINs were collected when the manager of the collection site was a local person. Including the local authorities in awareness raising and IEC/BCC can be an effective communication and organizational approach.

10. LLIN lifecycle is a key determinant of the number of nets collected

Determining when an LLIN is ready for retirement seems to vary widely. Although, manufacturers state that LLINs last between three-five years or twenty washes, field results and anecdotal evidence indicate that it could be less than that. An LLIN's lifecycle may be dependent on a few factors:

- The environmental conditions to which the net has been exposed (i.e. whether it has been in more humid or more arid conditions)
- Whether the LLIN was in a geographical area where water is scarce. These nets were in very poor condition (covered with a heavy coat of dust), but LLINs received from areas with a plentiful water supply looked almost brand new and may have even been over-washed.
- The perceptions of the owner and whether they think the net is ready to be retired (based on its condition, its intrinsic value etc.)

Phase II - Conclusions

The LLIN recycling pilot study in Madagascar, implemented by the USAID | DELIVER PROJECT, Task Order 3, was an initial effort to examine the feasibility of recycling as an option for LLINs that have been retired as bed nets and that present potential environmental and health risks. We found that the collection of retired LLINs was both feasible and acceptable.

A total of 22,559 retired LLINs were collected. This is compared to an initial target of 60,000 set by Trex, and 77,000 set by the project. The collection campaign was more successful in some pilot districts than others. It is likely that the success of a recycling campaign is dependent on, or affected by, four primary factors:

1. The population's willingness to give back retired LLINs

As noted in the findings, there were numerous reasons (as provided by the community members who were interviewed) that influenced their willingness to return their retired LLIN(s). Some of the main reasons cited include:

- Whether or not they had received enough new LLINs to cover their family's needs (it could therefore be suggested that the success of the collection campaign is dependent on the success of the distribution campaign);
- Whether they had both *collected and installed* their new LLIN at home;
- They were using the net for alternative purposes (such as a fishing net, mattress cover etc.);
- They had paid for the old net and did not want to give it back for free;
- They had received their old net from another donor and did not understand why it was being collected by USAID.

Additionally, as indicated by the results from the first set of interviews/focus groups conducted in phase I, a willingness to give back may also be correlated with the level of knowledge that people have about the lifecycle of LLINs, and what they should be doing with expired LLINs.

2. The collection of LLINs from all potential collection sites

As mentioned earlier, our local representatives indicated that either the long distances or the difficulties in reaching some areas because of a lack of roads (which increased during the rainy season) made it almost impossible for their teams to visit 100 percent of the sites where distribution had previously occurred.

Based on an extrapolation model, if all the sites had been visited (with the assumption that the sites not visited would have given back the same percentage as the sites that were visited), only one district (Beloha) would have reached and even exceeded its target. However, the original target of 60,000 LLINs for the pilot would still not have been achieved, as the total number of retired LLINs collected would not likely have increased beyond an estimated 30,000.

3. The communication strategy

IEC/BCC communication activities are critical to the success of the recycling campaign. The pre-campaign IEC/BCC plan and training efforts should be coordinated with pre-campaign distribution activities.

Additionally, the message disseminated to households to explain the purpose of the campaign is also a major determinant in the outcome of the campaign.

Finally, the role of local leaders in the communication strategy is critical – as they can play a pivotal role in organizing, advocating and communicating about a retired net collection campaign.

4. The combination of the distribution and collection campaigns

Where possible the distribution campaign and the collection campaign should be organized and planned as one project. It is likely that many of the challenges affecting the distribution campaign, including late pre-campaign activities, late household census and late delivery of the job-aide tool had a negative effect on the retired LLIN collection campaign IEC activities. Logistics will also be easier if the two are planned together.

In addition to the above listed reasons, factors such as timing of the two campaigns, and the availability local infrastructure (i.e. warehouses, transportation, a compactor etc.) also play a role in the success of a recycling campaign.

Next Steps: Phase III – Recycling and Analysis

Phase III (recycling and analysis) is ongoing; the collected LLINs from Madagascar have arrived in the United States. At the time of this report's production, Trex is arranging for the testing of the collected polyethylene and polyester LLINs to determine their material properties. In collaboration with the World Health Organization (WHO) and the United Nations Environment Programme (UNEP), the plastic polymers from the collected LLINs will also be tested for pesticide residue.

Container Delivery and Evaluation of the Collected LLINs

On arrival at Trex, each container will be unloaded (as mentioned, the collected LLINs were already sorted and packed in bales according to polymer type). As they are unloaded, each bale is to be visually inspected for contamination, including moisture. The bales are also to be weighed to determine the total quantity of polyethylene and polyester LLINs.

Several bales of polyethylene and polyester LLINs will be broken apart and samples evaluated. These LLINs will be tested to determine their material properties (i.e. moisture, standard melt flow, ash, color, and rheometric melt flow).

The polyester LLINs, with the test data, will be supplied to polyester recyclers/end-users for additional evaluation and ultimate recycling. Trex will recycle the polyethylene LLINs into the raw material to be used for building materials.

Trex Process Evaluation

The polyethylene LLINs that Trex will ultimately recycle will be evaluated in three raw material manufacturing operations:

1. 100 percent of raw material feed through a densification process;
2. 10–40 percent of raw material feed through a melt filtration pellet process;
3. 100 percent of raw material feed through a melt filtration pellet process;

The output from all three processes will be evaluated and the material incorporated into a raw material feed for manufacturing Trex products. This is a standard procedure that all of Trex's materials are subject to.

Trex Product Evaluation

As mentioned above, the outputs from the three material manufacturing operations will be used to make Trex products. The LLINs plastics will be evaluated against standard acceptance criteria; accelerated aging tests may be required to confirm acceptability. This product evaluation will take two–four months.

After the tests are complete, Trex will determine if, and how much of, the recycled polyethylene LLINs can be used in their products. Based on their plastic characteristics, Trex will also determine if the LLINs can be recycled into other products.

If the trial run is successful, the company is enthusiastic about the prospect of obtaining more used LLINs, and perhaps bags in the future from other recycling campaigns. It can also potentially enhance their image in terms of social responsibility, through participation and leadership of an environmentally friendly initiative.

WHO/UNEP Residue Testing

In addition to Trex testing the LLIN polymers for their suitability in other products, WHO/UNEP will support the pilot by testing the plastic polymers of the LLINs for pesticide residual. This evaluation, which will take place at the University of Hanoi, in collaboration with WHO/UNEP, will take one–two months.

USAID | DELIVER PROJECT LLIN Recycling Pilot Project Evaluation

Each activity in Phase III is elaborated here in this report but once testing is complete and the results of the analysis are available, a separate report on Phase III will be written. This report will present a thorough review of the conclusions drawn from each phase of the pilot project. Of particular interest to the project will be an analysis of the total costs incurred, the results of the residual pesticide testing of the recycled material, and comments from Trex regarding its suitability for use in new manufacturing. Lessons learned from all phases of the pilot project will hopefully be of use to other countries to help them make recycling efforts a possibility and to provide some potentially sustainable business models.

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Appendix A

Results of Individual Questionnaires

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