



# Value for Money in LLIN Specifications Guidance

Ensuring highest value for money in LLIN procurement by balancing cost with end-user and program benefits

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Results for Development Institute

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## About R4D

**Results for Development (R4D)** is a nonprofit organization whose mission is to unlock solutions to tough development challenges that prevent people in low- and middle-income countries from realizing their full potential. Using multiple approaches in multiple sectors including Global Education, Global Health, Governance and Market Dynamics, R4D supports the discovery and implementation of new ideas for reducing poverty and improving lives around the world. To learn more visit [www.resultsfordevelopment.org](http://www.resultsfordevelopment.org)

## About NetWorks

**The NetWorks project** is a five-year USAID-funded global project that partners with country missions to improve and establish sustainable access to and use of Long Lasting Insecticidal Nets (LLINs). Through its comprehensive and innovative programming, NetWorks aims to build sustainable LLIN systems that bridge the key technical areas of advocacy, policy, distribution, monitoring, and communications in malaria endemic countries. Visit [www.networksmalaria.org](http://www.networksmalaria.org) for more information.

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# 1. Introduction

Long-lasting insecticide-treated net (LLIN) or “net” specifications today are highly fragmented across color, shape, size, packaging, labelling, and accessories, amongst other factors. There are currently over 200 variations of LLINs available on the market, including supplier offerings in over 10 listed colors and 20 sizes and shapes, with a wide variety of packaging and labelling options. Among these, ~25 combinations of net specifications represent the most commonly purchased products globally.<sup>1</sup>

Maintaining a wide range of net specifications is essential to ensure net usage (defined as use when a net is available within a household). However, the costs of net differentiation (i.e., prices, lead time) must also be taken into account relative to the evidence of usage and/ or programmatic benefits. The United States Agency for International Development (USAID)-funded NetWorks program and Results for Development Institute (R4D)

undertook a rigorous analysis of both costs and benefits to identify over 70 net specification parameters that offer highest value for money (VFM). A net specification was deemed as lower VFM when its associated costs were high, but evidence of its usage or programmatic benefits was low.

Given the importance of optimizing VFM in the current resource-constrained environment, the recommendations in this document pertain to donor-funded procurement of LLINs in particular. Undertaking global procurement in accordance with this guidance can achieve up to \$290M in savings over 5 years<sup>2</sup>, reduce LLIN delivery lead times, and address wastage concerns related to packaging issues.

This document will be updated every 1-2 years as new evidence on the costs and benefits of net specifications becomes available.

## II. Summary of recommendations<sup>3, 4</sup>

Specifications	Cost Premium (per net)	Recommendations
<b>Color</b>	Negligible, if any	Continue to purchase blue, green, and/or white nets; additional colors acceptable with strong program rationale
<b>Size</b>	<ul style="list-style-type: none"> <li>Height: \$0.79 per net for nets over 170cm tall</li> <li>Width: "Single-bed nets" or those &lt;130cm wide may restrict the number of persons who may sleep under it, therefore significantly reducing VFM</li> </ul>	<ul style="list-style-type: none"> <li>Height: Procure only ≤170cm tall nets</li> <li>Width: Procure only double-occupancy or greater nets (≥130cm)</li> </ul>
<b>Packaging</b>	\$0.11 per net for individual packaging	For mass campaigns, consider using bulk packaging <sup>5</sup>
<b>Graphic Design of LLIN Packaging</b>	4-6 weeks additional lead time for customized packaging <sup>6</sup> when not requested at tender issue	<ul style="list-style-type: none"> <li>The following customizations are acceptable if requested at tender issue: <ul style="list-style-type: none"> <li>Space on packaging for a standard image of a country flag or MoH logo; and/or a donor logo. These images must be provided at time of tender</li> <li>Standard "Not for resale" stamp</li> </ul> </li> <li>Care instructions in local languages as needed</li> <li>Highly specialized customization or artwork (i.e. picture of head of state) should not be included</li> </ul>
<b>Net Labels</b>	4-6 weeks additional lead time for customized labels when not requested at tender issue	<ul style="list-style-type: none"> <li>Include only standard label information (brand name, lot number, date of manufacture, size and material) in English and/or French</li> <li>Exceptions may apply only if strong programmatic rationale exists; in these instances customizations must be requested at tender issue</li> </ul>
<b>Hooks and strings for hanging</b>	\$0.08-\$0.10 per net	Until more data is available, avoid procuring these items except for first-time mass distributions

# III. Methodology

## Review of usage and programmatic benefits

To map usage and programmatic benefits, a rigorous analysis was conducted including a review of the published literature, grey literature, and a series of expert interviews. This included a review of data from

47 studies representing settings in sub-Saharan Africa, South Asia and the Solomon Islands, and consultations with ten experts in the field with significant experience in mass distributions in sub-Saharan Africa. It also included a review of grey literature, specifically the Roll Back Malaria (RBM) Toolbox, Alliance for Malaria Prevention's (AMP's) Toolkit for Mass Campaigns, and the RBM Harmonization Working Group's Guidance for Round 11 on LLINs, which summarizes World Health Organization (WHO) policy and best practices for countries planning large-scale net distributions.

The analysis of the relevant published literature revealed little quantitative data demonstrating that specifications influence net use. Studies surveying available published articles from 1990 through 2011 conclude that the most common reasons given for not using a net when one is available are discomfort due to perceived heat and perceived low mosquito density.<sup>7,8,9</sup> Only 5% of

responses cited "technical" reasons for non-use such as difficulty hanging or inconvenience, some of which could potentially have linkages to net specifications.

Where correlation has been evaluated specifically between net size, shape or color and net hang-up rates, few or no associations have been found.<sup>10,11,12,13,14</sup> In an environment of free net distribution, net specifications have not historically been a driving factor of use. Exceptions are noted in the sections below.

## Analysis of Costs

To evaluate the cost impact of varying specifications, analysis of a composite database of Global Fund Price and Quality Reporting (PQR) and President's Malaria Initiative (PMI) LLIN procurement data was conducted. The database included data from 2007 to 2010, representing approximately two-thirds of the 370 million LLINs purchased during that time frame.<sup>15,16</sup> Certain specifications, specifically accessories (e.g. hooks and strings) and net packaging and labelling, are not included in procurement databases. For these specifications, this evaluation relied on extensive interviews with WHO Pesticide Evaluation Scheme (WHOPES)-recommended suppliers to determine impact on lead times and price.

# IV. Cost-benefit analysis of net specifications

## Color

**Cost:** Though suppliers currently offer approximately 10 net colors, the vast majority of LLINs procured are just three colors – white, blue, and green. There is generally negligible difference in net price and/or production costs between the various colors.<sup>17</sup> However, overly high fragmentation in color choices significantly complicates supplier production planning and inventory management, which may indirectly be passed along in higher prices and lead times across all LLINs

**Benefits:** Program planners acknowledge that individuals and households have preferences for certain colors. The evidence, however, does not indicate that these preferences play a significant role in whether nets are or are not used.

Given the prevalence of recent mass distribution campaigns, the majority of nets in many countries are the same color. This results in limited opportunities to compare color preferences. One study conducted in Ghana, however, found that blue nets were used more than other nets.<sup>18</sup>

For mass distribution it can be programmatically challenging to respond to individual and household preferences for color, as one cannot assume that preferences will remain consistent over time and/or will be homogenous even within areas where color preferences have been measured. For example, darker nets are preferred by some since they are perceived to hide dirt better and thus are easier to take care of as they need not be washed as often. Meanwhile white nets may be preferred by other households due to the perception that they look 'clean'.<sup>19</sup>

Though evidence does not indicate that color preferences play a significant role in net use, differentiation can help track nets in surveys or monitoring activities. For example programs may use this to track the year of distribution and ensure appropriate timing for replacement nets. As a result having some diversity of colors available for different time periods and distribution channels (e.g., white LLINs through routine distribution channels such as free antenatal care (ANC), blue LLINs for a mass campaign) can be beneficial from a programmatic point of view.

### Recommendations

Given the programmatic benefits of allowing for multiple colors, countries should be encouraged to continue purchasing blue, green, and/or white nets consistent with current practices. To minimize excessive fragmentation, procurement of additional colors should be allowed only in those instances where a strong program rationale can be presented (e.g., for program monitoring purposes).

## Shape and size

In 2010, Global Fund and PMI-supported countries purchased over 20 different net sizes and two different shapes (rectangular and circular).<sup>20</sup> These size and shape differences have significant cost implications for large-scale procurements.

### Shape

**Cost:** There is a \$0.60-\$2.00 premium<sup>21</sup> for circular nets compared to a "standard" (190x180x150cm) sized rectangular net. This is due to the costs of additional material, stitching and cutting needed to create circular nets, and the plastic ring required at the top of the net to hold their shape. There is also a resultant premium of higher shipping costs for these nets since they can take up twice as much volume as rectangular nets.<sup>22</sup>

**Benefits:** Recent large-scale procurements to reach universal coverage have focused on rectangular nets, and the procurement volume of circular nets has been quite low, resulting in very few surveys measuring preference for different shapes.<sup>23</sup> Anecdotally, both circular and rectangular shapes are accepted based on ease of hanging, number of points that need to be nailed into a wall, shape of room or dwelling, ability to tie up during the day, general aesthetics, and familiarity. Analysis of the 2007 Malaria Indicator Survey (MIS) from Mozambique showed that those who did not have their preferred net shape were not significantly less likely to use their nets compared to those who did have their preferred net shape.<sup>24</sup> However, in a 2007 household survey in 23 communities of Amhara and Oromia regional states in Ethiopia, circular nets were more than twice as likely to be used as rectangular nets when controlling for other factors.<sup>25,26</sup>



## Size

**Cost:** Rectangular nets above 170cm in height command an average price premium of \$0.79 above a standard sized net.<sup>27</sup> The price premium of these nets is driven by two factors: 1) the cost of the additional raw material required to produce a larger net and 2) loss in production efficiencies. Though knitting equipment varies, newer knitting machines can often produce four rolls at a time of up to 170cm (the net height).<sup>28</sup> Creating nets taller than 170cm reduces the machine's capacity from four rolls to three rolls, significantly reducing production efficiency.

### Benefits:

*Height (rectangular):* No evidence exists to indicate that nets taller than 170cm (equivalent to 5'7") drive increased usage. These nets offer sufficient space for individuals (adults and/or children) to sit and/or sleep beneath the net, taking into consideration material required to tuck the net under the sleeping space.<sup>29</sup>

*Width (rectangular):* Universal coverage is defined as one LLIN per two people. As such, procured nets should be wide enough to accommodate two adults. Nets that cover only single/twin beds may be able to accommodate more than one child, but may only be able to protect one rather than two adults, making them less cost-effective in achieving and maintaining universal coverage goals. Analysis of LLIN procurement data indicates that almost all countries are already procuring LLINs that are 'family size' or greater (e.g. width of 130cm or greater<sup>30</sup>), and should continue to do so.

## Recommendations

- *Shape:* To date, the significant price difference between circular versus rectangular nets has driven limited procurement of circular nets. It is anticipated that this price difference will likely remain a factor in future procurement decisions. Given both the cost and the limited data showing potentially increased usage of circular nets, recommendations regarding shape are not included in this version of the guidance. It is recommended that future studies more closely examine the overall usage benefits of circular nets to allow for more robust analysis.
- *Height (rectangular):* Donor-funds should be used towards procuring nets that are  $\leq 170$ cm in height given the significant cost premiums associated with over-sized nets and the absence of published data that these nets generate higher usage rates.
- *Width (rectangular):* To remain consistent with universal coverage goals, countries should continue to procure nets at least 130cm wide to accommodate at least two adults.

## Bulk Packaging of LLINs

**Cost:** Currently, when a supplier ships nets for distribution each net has an individual package and the individually packaged nets are also 'baled' with an outer plastic wrapping into groups of 40, 50 or 100 nets.<sup>31</sup> The premium for including individual net packaging is \$0.11 per net.<sup>32</sup> Additionally significant management and financial costs arise in planning and executing the collection and proper disposal of discarded net packaging during mass distribution campaigns to limit environmental harm. During these campaigns the bags are frequently discarded prior to distribution (see discussion below). Interim WHO guidelines prohibit packaging from being re-used, burned in open air, or disposed of in landfills due to environmental concerns.<sup>33</sup> Given these restrictions, countries report that they are storing packaging and awaiting further instructions.<sup>34</sup> Alternatively, countries are disposing of packaging locally at the clinic and household level through methods at times inconsistent with WHO's temporarily acceptable practices for disposal.

**Benefits:** The benefits of individually packaged nets for mass distribution campaigns are very low, since packaging is very frequently either ripped open or removed entirely prior to distribution to prevent resale.<sup>35</sup> Individual packaging is however retained when LLINs are sold in commercial markets or provided via continuous distribution channels such as ANC and EPI.

## Recommendations

Countries should consider pursuing bulk packaging for mass distribution campaigns in order to save money and eliminate common logistical and environmental challenges. When pursuing bulk packaging, it is important that countries ensure appropriate distribution of safety and usage information to the end user<sup>36</sup> as well as appropriate worker safety practices for individuals who distribute nets.<sup>37</sup> Uganda successfully distributed over 7 million LLINs to pregnant women and children under five in 2010-11 using bulk packaging or "naked nets", and reported that this reduced the cost per net both for procurement and for overall distribution costs, saving approximately \$700,000.<sup>38</sup> PSI has also successfully distributed nets that are individually secured with a cardboard band rather than a traditional plastic wrapper to eliminate waste and reduce cost.

## Graphic Design of LLIN Packaging

**Cost:** Countries and donors often request artwork on net packaging, such as a country flag, donor logo, or country logo. Suppliers cite that purchasers (i.e., countries or other procurement bodies) typically do not provide the artwork specifications in the tender document, and may even request these after suppliers have been awarded an order and begun production. This can create up to a 4-6 week delay in delivery when requested after tender issue, particularly for highly customized specifications, such as a picture of the head of state, which can necessitate numerous back-and-forth communications.<sup>39</sup>

**Benefits:** Experts indicate that including a country flag, standard MoH, or donor logo on the package is often used to reduce cross-country leakage and is therefore important to maintain. However, additional artwork or specialized customization on the package beyond this does not confer similar benefits and can increase lead times significantly.

### Recommendations

Given both the tracking benefits and country priorities to identify nets that donor or country funds have purchased, packaging should provide a dedicated space available only for: 1) a standard image of a country flag or MoH logo; and/or a donor logo 2) a "Not for resale" graphic, and 3) care instructions in local/appropriate language(s). Of critical importance, requests to include these standard images should be provided at tender issue to avert delays, or will otherwise be disallowed. Highly customized packaging, such as faces of politicians or other political messages, is unlikely to lead to programmatic or net usage benefits, and thus should not be included.

## Customized Labels

**Cost:** Most standard net labels (also known as "tags") contain information on size, manufacturer, material, care instructions, date of production, and batch or lot number, with options available to include the information in English and/or French languages.<sup>40</sup> However, some purchasers request additional customizations, such as inclusion of donor logo, often several weeks after an order has been awarded. Customization requests after tender issue can often require unpacking all nets, removing and

re-sewing labels, and repacking nets, adding considerable resultant costs and up to 4-6 weeks in lead time.<sup>41</sup> Customized labelling can also lead to significant inventory management challenges for suppliers by reducing the fungibility of stocks.

**Benefits:** For small scale net tracking studies as well as for standard data collection for the MIS household questionnaire<sup>42</sup>, it can be useful to have the ability to distinguish brands of nets in the field. The standard information included in a net label (as noted above) is sufficient for these purposes. Furthermore, brands of nets can be identified using other distinguishing elements (corner loops, shape of label, etc.) even when the tag may be missing.<sup>43</sup>

### Recommendations

For standard donor-funded mass procurements, net labels should not be customized beyond the standard information given the potential for increased lead times and inventory management challenges. Options to include information in English and/or French should continue to be available.<sup>44</sup> Exceptions may apply for smaller scale donor-funded procurements when justified by research study or other program purposes. In these situations, any requested customizations to the net label must be provided at the time of tender issue.

## Hooks, Strings, and Hanging Paraphernalia

**Cost:** The cost of including hooks and strings with nets is estimated at around \$0.08 - \$0.10.<sup>45</sup>

**Benefits:** Though more research is necessary, limited evidence indicates that the benefits of including hooks and strings with the net will likely vary depending upon previous exposure to LLINs. Anecdotal evidence indicates that first-time net users may benefit from hooks and strings when they are learning how to hang up nets. However, as most countries have now implemented at least one mass LLIN distribution campaign, most households are now familiar with how to hang LLINs. In a recent study in Uganda<sup>46</sup> on the effects of "hang up campaign" visits on net use, overall, 90% of households received a package of hooks and strings; of these, 80% used the materials. However, among those who either did not receive the hooks or those who did but chose not to use them, the vast majority (84%) reported no difficulty hanging their nets.

## *Recommendations*

Countries should examine existing data for hanging rates of LLINs, if possible, and take into account net use in net-owning households as described in the updated RBM Monitoring and Evaluation Group (MERG) core indicator guidance, in order to assess whether problems with hanging nets are a key barrier.

Including hooks and strings or conducting hang up campaigns may be valuable for first-time distributions or if lack of materials for hanging, specifically, is found to be a key barrier to net use. For subsequent distributions, on going mass or community communication is likely to be sufficient in many areas to remind the population to use their nets, and may provide more VFM than the costly procurement of hooks and strings.

## V. Guidance for collecting further evidence

Countries should continue to actively monitor net use rates as described in the updated RBM MERG core indicator guidance. If data indicates that there are high rates of non-use amongst net-owning households, countries should gather data on what factors are driving non-use. If data indicates that non-use is driven by net specifications and net use rates may be improved by procuring alternate specifications, countries should use this data to justify departures from the VFM specifications recommended above.

Countries should take into account the following guidelines when providing data to justify donor-funded procurements with specifications outside of these recommendations:

- Data should be drawn from high quality randomized household surveys, preferably through the inclusion of questions on Demographic Health Surveys (DHS), MIS

and Multiple Indicator Cluster Surveys (MICS) in order to show generalizability or nationwide homogeneity of preferences.

- Studies should follow best practices for household surveys, including ethical committee review, random sampling, sample size sufficient to draw robust conclusions, high quality data management, etc.
- Qualitative findings are not sufficient to produce a generalizable recommendation about preferences or net specification impact on net use, but qualitative studies can serve to inform countries of developing trends in net use that could then be explored further in larger quantitative surveys.

The WHO document Basic epidemiology, 2nd Edition, Chapter 3 should be consulted for further detail on how to structure quantitative randomized household surveys.

# Endnotes

- 1 Analysis of Global Fund Price and Quality Reporting (PQR) and PMI data; Includes 8 sizes and 3 colors
- 2 Results for Development Institute, Expanding Access to LLINs: A Global Market Dynamics Approach, April 2012
- 3 Exceptions to these recommendations for donor-funded procurements may include specialized packaging requirements for social marketing programs or other smaller scale procurements and bulk packaging for non-mass distribution procurements. This guidance is not intended to inform retail distribution channels.
- 4 To date, the significant price difference between circular versus rectangular nets has driven limited procurement of circular nets. It is anticipated that this price difference will likely remain a factor in future procurement decisions. Given both the cost and the limited data showing potentially increased usage of circular nets, recommendations regarding shape are not included in this version of the guidance
- 5 When pursuing bulk packaging, it is important that countries ensure appropriate distribution of safety and usage information to the end user as well as appropriate worker safety practices for individuals who distribute nets
- 6 It can also add a small cost premium of \$.03 per net
- 7 Pulford J, Hetzel MW, Bryant M, Siba PM, Mueller I: Reported reasons for not using a mosquito net when one is available: A review of the published literature. *Malar J* 2011, 10:83.
- 8 Atieli HE, Zhou G, Afrane YA, Lee MC, Mwanzo I, Githeko AK, Yan G: Insecticide-treated net (ITN) ownership, usage, and malaria transmission in the highlands of western Kenya. *Parasit Vectors* 2011, 4:1113.
- 9 However, as Pulford et al note, the majority of studies omit key information that would allow for cross-comparison and generalization, leaving the conclusions highly tentative until a 'greater quantity of dedicated, well designed and reported studies are available in the published literature.'
- 10 Baume CA, Reithinger R, Woldehanna S: Factors associated with use and non-use of mosquito nets owned in Oromia and Amhara regional states, Ethiopia. *Malar J* 2009, 8:264.
- 11 Banek K, Kilian A, Allan R: Evaluation of interceptor long-lasting insecticidal nets in eight communities in Liberia. *Malar J* 2010, 9:84.
- 12 Baume CA, Koh AC: Predictors of mosquito net use in Ghana. *Malar J* 2011, 10:1265.
- 13 Macintyre K, Littrell M, Keating J, Hamainza B, Miller J, Eisele TP: Determinants of hanging and use of ITNs in the context of near universal coverage in Zambia. *Health Policy Plan* 2011.
- 14 Graves PM, Ngondi JM, Hwang J, Getachew A, Gebre T, Mosher AW, Patterson AE, Shargie EB, Tadesse Z, Wolkon A, Reithinger R, Emerson PM, Richards FO: Factors associated with mosquito net use by individuals in households owning nets in Ethiopia. *Malar J* 2011, 10:1354.
- 15 Net mapping project data
- 16 That said it is important to note that specific descriptions of price premiums below are drawn from 2010 data to ensure a full year of current and updated pricing data. At time of publication, complete 2011 data is not available due to ~6 month reporting lag in PQR.
- 17 Interviews with WHOPES-recommended suppliers. While this can't be verified from GF PQR data because this field isn't included, PMI data verifies that there is no statistically significant difference in cost of colored nets.
- 18 Baume CA, Koh AC: Predictors of mosquito net use in Ghana. *Malar J* 2011, 10:1265.
- 19 Presentation of Preliminary Findings: Long lasting insecticide treated net coverage and durability surveys, Dadaab Refugee camps, December 2009. Sarah Hoibak – Consultant UNHCR, personal communication.
- 20 A third shape, hammock, was also procured. However, as hammock-shaped nets are primarily used in Southeast Asia and make up less than 0.5% of procurements; analysis of this net shape is not presented here.
- 21 Volume of circular nets procured have been quite low; premiums may change with larger procurements.
- 22 AMP Toolkit, page 10-12.
- 23 Preliminary qualitative reports from Somali refugee camps in Kenya and from Senegal (Hoibak, personal communication regarding Dadaab IDP camp in Kenya; preliminary findings of JHUCCP's NetWorks Culture of Net Use study in Senegal) have described households that have converted rectangular nets into circular ones, often paying tailors for the service. If households are motivated to adapt their nets from one shape to another, this takes much of the burden off of countries and donors to supply a more expensive shape to consumers. On the other hand, nets that are converted from one shape to the other may develop holes or rips more quickly due to increased stress on the hanging point.
- 24 Controlling for type of net (treated/untreated), geographic area, socio-economic status, age of the net and urban/rural status, having one's preferred shape of net was not significantly associated with net use.
- 25 Baume CA, Reithinger R, Woldehanna S: Factors associated with use and non-use of mosquito nets owned in Oromia and Amhara regional states, Ethiopia. *Malar J* 2009, 8:264.
- 26 In these communities, qualitative results from the same study indicated that conical nets were considered much easier to hang than rectangular nets.
- 27 Analysis of Global Fund Price and Quality Reporting (PQR) and PMI data
- 28 This depends on the width of the knitting machine; which varies depending on the equipment used by the supplier. In some cases, suppliers may have knitting equipment where this cut-off can be 150cm. However given that the pricing data available does not reflect a price premium between 150 to 170cm tall nets, a 170cm threshold is presented here.
- 29 To allow for tucking underneath the sleeping surface, 10-20cm may be needed, leaving 150-160cm of the net available, which appears to be sufficient for accommodating even tall individuals. As an illustration, an individual over 1.8m (or 5'11") in height, even when sitting on the sleeping surface, would require only 90-100cm to cover the length of their torso.

- 30 A review of sizes offered by suppliers in brochures finds that they are fairly standard: "Single" or "XS" are 70cm wide; Double or Small 100cm; "Family" or "Medium" 130cm; "Large" or "Large Family" 160cm; and "Extra Family" or "XL" 180-190cm.
- 31 The number of nets per bale varies by supplier and net brand.
- 32 Multiple WHOPES-recommended supplier interviews. This field is not included in GF PQR or PMI data.
- 33 WHO Draft Interim Guidelines on the Sound Management of Packaging for LLINs. Given that the guidelines were only finalized in late 2011, many countries have had to make decisions about management of LLIN packaging prior to the release of the guidelines. In most cases, LLIN pack- aging is ripped open and disposed of at household level.
- 34 Aba Bafoe-Wilmot, Ghana NMCP Vector Control Unit, personal communication
- 35 AMP Toolkit pages 5-9 and 7-24.
- 36 These channels could include a leaflet that is distributed with or folded into the net and/or social marketing posters in public community locations; suppliers have indicated strong support for these alternate approaches.
- 37 Minimal personal protective equipment includes but is not limited to: daily changed long sleeve shirts and frequently changed rubber gloves. (Final draft interim WHO guidance on net disposal).
- 38 Susan Mpanga Mukasa, PSI/Uganda, personal communication. Nets were cheaper to transport due to reduced weight, there was no logistics or costs required to dispose of the packaging, and the net resale value was reduced. Breaking bulk at warehouse level and counting individual nets at distribution was slightly more difficult but rounding up to the nearest bale for each distribution point was a workable solution to these challenges.
- 39 It can also add a small price premium of \$.03 per net
- 40 Review of net labels from 9 WHOPES-recommended suppliers and WHO document "Technical consultation on specifications and quality control of netting materials and mosquito nets, 2005".
- 41 Multiple WHOPES-recommended supplier interviews
- 42 Guidance developed by the RBM Monitoring and Evaluation Reference Group for the Malaria Indicator Survey can be found at <http://www.rollbackmalaria.org/mechanisms/merg.html>.
- 43 Smith SC, Joshi UB, Grabowsky M, Selanikio J, Nobiya T, Aapore T. Evaluation of bednets after 38 months of household use in northwest Ghana. *Am J Trop Med Hyg* 2007, 77:6 Suppl243-248.
- 44 As the information on the net label is primarily used by individuals who track nets- program experts indicate that Lusophone countries are able to understand the brand names and lot numbers in English or French.
- 45 Based on interviews with multiple WHOPES-recommended suppliers. This field is not available in the PQR or PMI databases
- 46 Data from the NetWorks Uganda Hang Up Study, conducted in 2011 in Kamuli District, Uganda. Publication is forthcoming.

# Appendix A: Abbreviations

AMP	Alliance for Malaria Prevention
ANC	Antenatal Care
DHS	Demographic and Health Surveys
EPI	Expanded Program Immunization
LLIN	Long-Lasting Insecticide-treated Nets
MERG	(RBM) Monitoring and Evaluation Group
MICS	Multiple Indicator Cluster Surveys
MIS	Malaria Indicator Survey
MoH	Ministry of Health
PMI	President's Malaria Initiative
PQR	(Global Fund) Price and Quality Reporting Database
R4D	Results for Development
RBM	Roll Back Malaria
USAID	United States Agency for International Development
VFM	Value for Money
WHO	World Health Organization
WHOPES	World Health Organization Pesticide Evaluation Scheme

# Appendix B: Literature reviewed

1. Adongo PB, Kirkwood B, Kendall C "How local community knowledge about malaria affects insecticide-treated net use in northern Ghana" *Trop Med Int Health* 2005, 10:4366-378.
2. Afolabi BM, Sofola OT, Fatunmbi BS, Komakech W, Okoh F, Saliu O, Otsemobor P, Oresanya OB, Amajoh CN, Fasiku D, Jalingo I "Household possession, use and non-use of treated or untreated mosquito nets in two ecologically diverse regions of Nigeria–Niger delta and Sahel Savannah" *Malar J* 2009, 8:30.
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4. Ahmed SM, Hossain S, Kabir MM, Roy S "Free distribution of insecticidal bed nets improves possession and preferential use by households and is equitable: Findings from two cross-sectional surveys in thirteen malaria endemic districts of Bangladesh" *Malar J* 2011, 10:1357.
5. Ahmed SM, Zerihun A "Possession and usage of insecticidal bed nets among the people of Uganda: Is BRAC Uganda health programme pursuing a pro-poor path?" *PLoS One* 2010, 5:9.
6. Alaii JA, Hawley WA, Kolczak MS, ter Kuile FO, Gimnig JE, Vulule JM, Odhacha A, Oloo AJ, Nahlen BL, Phillips-Howard PA "Factors affecting use of permethrin-treated bed nets during a randomized controlled trial in western Kenya" *Am J Trop Med Hyg* 2003, 68:4 Suppl137-141.
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# Appendix C: Field experts consulted

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3. Marcy Erskine, IFRC
4. Albert Kilian, TropHealth
5. Kojo Lokko, JHU-CCP
6. Susan Mpanga Mukasa, PSI/Uganda
7. Jessica Rockwood, DFI
8. Richmond Ato Selby, Malaria Consortium
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