

# Role of the private sector in production and distribution of long lasting insecticide treated nets for malaria control

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## Question

What are the barriers and opportunities to expanding the role of the private sector in the distribution of LLINs in sub-Saharan Africa and in the production of LLINs at the global level?

## Contents

1. Overview
2. Conceptual Framework
3. LLIN Demand Side
4. LLIN Supply Side: Production
5. LLIN Supply Side: Distribution
6. Lessons and Key Questions
7. References
8. Annexes

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## 1. Overview

The private sector producing and distributing mosquito nets in malaria control has been exposed to factors beyond usual market influences. The supply of untreated nets was diverse and often local. It was maintained with the introduction of insecticide treatment sachets (supplied by donors) to bundle with untreated nets sold by retailers. Voucher schemes aimed at targeting vulnerable groups e.g. pregnant women and young children aimed to sustain and expand the commercial sector through public private partnership. The biggest influences on the private sector was a huge increase in donor funding of free mass campaigns and the WHO and the Global Malaria Programme change in 2007 in the overall global strategy from targeted protection of vulnerable groups (pregnant women and children under 5 years old) to universal coverage and recommendation of long lasting insecticide treated nets (LLINs) instead of insecticide treated nets (ITNs). The private sector then had to compete with international companies with the technology to produce LLINs; bulk purchasing by donors; higher unit costs; and competition with free distribution by donors through the established network of the healthcare system.

Donor funding is now levelling and there remains a gap in funding required to meet universal coverage with LLINs. Donors and country programmes are now exploring keep-up strategies that rekindle, expand and diversify the role of the private sector in the sustainable production and distribution of LLINs. Commercial markets are a valuable source of nets and where strong commercial markets exist or are developing, they should be encouraged as they can provide important benefits, ensuring longer-term access and enhancing management of logistics and education efforts. However, lessons must be learnt from the impact of mass campaigns of free nets and a change in global policy.

This report provides a review of key literature and evidence on the LLINs and private sector. The evidence base for this report is vast and spans more than twenty years of research evidence, policy documents and implementation programme evaluations and data from sub-Saharan Africa and Asia. The relevant literature spans academic publications in biological and social sciences as well as implementation science and health economics.

This report supplements the pre-existing evidence base with original analysis by experts in the field: Efundem Agboraw and Eve Worrall from LSTM. The authors have applied a traditional economic theory framework to analyse the barriers and opportunities to expanding the role of the private sector in the distribution of LLINs in sub-Saharan Africa and in the production of LLINs. The report also includes the authors' original presentation and analysis of data from various sources on LLINs and the private sector. A mind map of the constraints to impeding the growth of the commercial sector in LLIN markets is provided in Annex 2.

## Key Findings

- The private sector is diverse and ranges from owners of small shops or market stalls selling mosquito nets to huge multi-national corporations manufacturing millions of LLINs a year. Supply side actors interact dynamically with numerous demand side actors at multiple levels resulting in an extremely complex market. As LLINs are a donor-financed public good, global and country level health policy influences the role and activities of private sector actors, involving them in non-traditional market activities such as obtaining regulatory approval for public health use and responding to public tenders.

- The demand side of the LLIN market is dominated by procurement of LLINs by public health actors on behalf of end users. Free mass distribution campaigns have allowed a fast increase in coverage of LLINs ('catch-up'). Keep-up strategies have tended to have similar procurement and financing, with distribution being coordinated by National Malaria Control Programmes (NMCPs) using systems such as antenatal care, expanded programme on immunisation or various community based models (e.g. community health workers or volunteers). However, this may have dampened demand for LLINs provided through the private retail sector, even when highly subsidised, with a negative effect on the commercial LLIN market.
- LLINs are a public health intervention so the argument for subsidy to increase consumption of merit goods and improve equity is strong. Several demand side voucher schemes were implemented to provide a way of subsidising the price paid by consumers (often pregnant women and children) without bypassing (crowding out) the private sector distribution mechanism. The most well-known of these schemes is the Tanzanian National Voucher Scheme (TNVS). Comparison with the Ghanaian voucher scheme which was never implemented has highlighted the importance of context.
- Enabling factors which may expand and diversify the private sector's role in the production and distribution of LLINs include:
  - Engagement of all stakeholders (public and private – formal and informal) in a sustained, well-coordinated and managed partnership with a shared vision.
  - Favourable insecticide regulatory conditions and harmonised regulatory standards at regional level.
  - Permanent removal of any form of taxation and tariffs on end product and LLIN material (which could be tailored in-country) and reintroduction of tax on ITNs.
  - Communication well in advance of mass distribution and support of the private sector through training to retailers as well as potential credit mechanisms to allow increased stocks ahead of issuing of vouchers.
  - Generic demand creation by the public sector e.g. social marketing that directly engages the local manufacturer and primes the market for them.
  - A reduction in donor dependency through targeted subsidy schemes for vulnerable groups coupled with commercial sale of a more expensive range of products which meet preferences of consumers who are willing and able to pay for LLINs.
  - Diversification in vector control strategies including greater emphasis on housing improvements (e.g. screening) and personal protection measure in providing protection against disease vectors.
  - Advocacy of the private sector to invest could create awareness and sensitise businesses that it is economically beneficial to invest in malaria control by estimating the economic burden of malaria on businesses.
- Challenges in expanding and diversifying the private sector's role in the production and distribution of LLINs include:

- Equity of access to LLIN and other malaria prevention, treatment and diagnostics
- Developing a commercial market in poor and/or rural areas
- Addressing the higher unit cost of LLINs (and next-generation LLINs in areas of resistance). High-level global subsidies may need to be considered to improve the availability of affordable high quality products.
- Developing effective strategies to tackle fake LLINs and fraud

Further research is required to determine whether it is possible to combine free LLINs delivered through mass campaigns (perhaps targeted to groups most at risk including pregnant women, infants and school children) with a system which relies on the commercial sector to distribute LLINs, and to determine whether the coverage achieved through this combined system is more sustainable than that which any one system can achieve on its own.

## 2. Conceptual Framework

In 2015 there were an estimated 212 million new cases of malaria and 429 000 deaths (World Health Organization, 2016). The WHO African Region continues to dominate the number of cases with an estimated 90% of malaria cases and 92% of malaria deaths in 2015. The WHO South-East Asia Region accounted for 7% of global malaria cases and 6% of malaria deaths. Sleeping under a mosquito net protects the individual user from mosquito bites, but treating the net with an insecticide turns it into a public health intervention: effective insecticides kill mosquitoes, preventing further transmission.

In sub-Saharan Africa, the percentage of the at risk population that slept under an ITN/LLIN increased from 5% to 53% between 2005 and 2015 (World Health Organization, 2016). Over the past decade, there have been significant advancements made towards achieving malaria control-related goals and the scale-up of interventions has resulted in declines in malaria mortality and morbidity (World Health Organization, 2016). The scale-up of vector control, and the increased coverage and use of LLINs, is considered a major contributor to these achievements. Bhatt et al. estimated that 68% of the malaria cases averted between 2000 and 2015 were due to bed net use (Bhatt et al. 2015). However, these recent gains in malaria control could be jeopardised by mosquito resistance to the insecticides used on ITN/LLINs and inadequate financing to maintain coverage levels. Global investment for malaria increased between 2000 and 2010. However, funding has since levelled, totally US\$ 2.9 billion in 2015; less than half of the 2020 milestone of US\$ 6.4 billion (World Health Organization, 2016). This has led to concerns about the future of LLIN coverage, and a renewed interest in looking for additional private sector investment to finance, produce and deliver LLINs.

Box 1 Definition of Untreated Mosquito Net, ITN and LLIN

*An untreated mosquito net is a net that is used to protect the user from the bites of mosquitoes. It does not kill mosquitoes and therefore has no public health benefit*

*An insecticide-treated net (ITN) is a mosquito net that repels, disables and/or kills mosquitoes coming into contact with insecticide on the netting material.*

*A LLIN is a factory-treated mosquito net made with netting material that has insecticide*

*incorporated within or bound around the fibres. The net must retain its effective biological activity without re-treatment for at least 20 WHO standard washes under laboratory conditions and three years of recommended use under field conditions.*

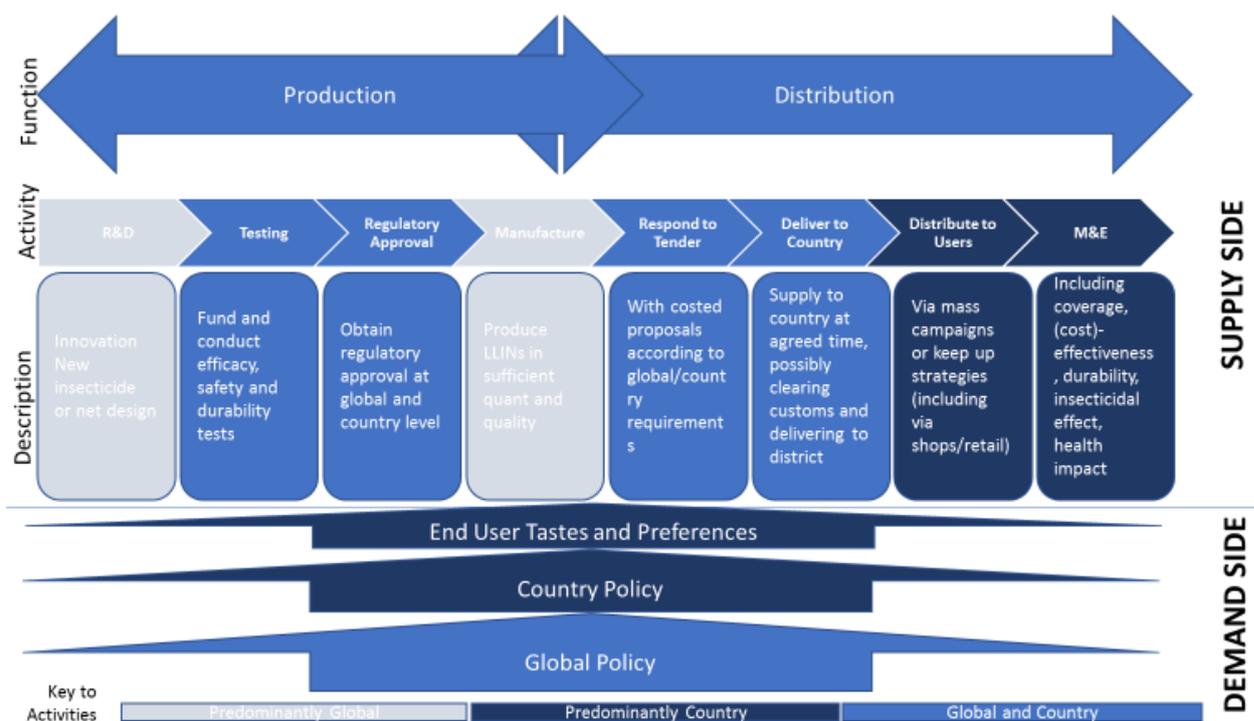
Source: Authors

The framework underpinning this report is traditional economic theory which analyses markets according to demand and supply side actors against the theory of a perfectly competitive (free) market. The **product** of interest is the LLIN as defined by the WHOPES evaluation standard. However, particularly at a household/retail level, LLINs compete with other mosquito nets that may be treated with insecticide or not. Thus, the scope of the market analysis encompasses the broad market for mosquito nets. For the purposes of this report, we define private sector as the **for-profit private sector**. This excludes all Non-Governmental Organisations (NGOs) or charities. The private sector is diverse and ranges from owners of small shops or market stalls selling mosquito nets to huge multi-national corporations manufacturing millions of LLINs a year. Just like in a perfectly competitive market, these supply side actors interact dynamically with multiple demand side actors at many levels resulting in an extremely complex market.

The demand side of the LLIN market is dominated by procurement of LLINs by public health actors on behalf of end users. Thus, the market size for LLINs is determined by global health (malaria) policy and financing, via its impact on (endemic) country level demand. The demand for untreated and insecticide treated mosquito nets is less influenced by public health actors, and is closer to that of a competitive market, with the tastes, preferences, and choices of individual consumers making up country and global level demand.

The supply side market functions of interest are the production and distribution of LLINs. Our conceptual framework (Figure 1), recognises that in the LLIN market these functions may overlap, and involve a set of traditional private for-profit sector activities, ranging from product research and development (R&D), testing, manufacturing, delivery to distribution. However, because LLINs are a predominantly donor-financed public good, global and country level health policy influences the role and activities of private sector actors, involving them in less non-traditional market activities such as obtaining regulatory approval for public health use and responding to public tenders. A further complication is that the LLIN market is global, but some activities (e.g. testing, regulatory approval, tendering, delivery) often take place globally and must be repeated in multiple countries either in parallel or sequentially.

Figure 1. Conceptual Framework: Functions, Activities and Description of LLIN markets where private sector plays a role



Source: Authors

### 3. LLIN Demand Side

#### Market Failure

The public health rationale for subsidised vector control is clear, but the economic argument for subsidy is also strong and focuses on two key concerns (market failures); the need to increase consumption of merit goods and address health and economic inequity. LLINs are a classic example of merit goods, generating positive externalities (malaria transmission reducing effects) which are not fully recognised by users, resulting in sub-optimal demand (under consumption). Poverty and lack of knowledge of the benefits of LLINs amongst communities, coupled with inadequate resources to meet health needs in most developing countries, means that without international donor intervention, LLINs use would not achieve the coverage levels required to reap the public benefits. In turn this failure to use effective tools to address the economic burden of malaria which falls disproportionately on the world's poorest countries would exacerbate inequity. These arguments were put forward convincingly in the 1990's leading to a massive increase in public and philanthropic financing, a donor driven LLIN market and extensive LLIN distribution via public sector channels in malaria endemic countries.

#### Public Sector Intervention

A brief history of global health policy in relation to ITNs and LLINs is presented below to help the reader understand the origins of current global demand for LLINs. Running alongside these developments are key milestones in global health policy, notably the adoption of the Millennium

Development Goals (MDGs) in 2000 which specifically called for donors and countries to combat malaria and reduce child mortality.

### **1984-1999 Development ITNs as a public health tool**

The first successful evaluation of pyrethroid impregnated (treated) mosquito nets against malaria vectors was published in 1984 (Darriet, Robert, Tho Vien, & Carnevale, 1984). In the 1990s, studies showed that mosquito nets treated with pyrethroid insecticides (ITNs) were safe and highly efficacious in reducing all cause childhood morbidity (D'Alessandro et al., 1995) and were highly cost-effective (Goodman, Coleman, & Mills, 1999). These developments sparked a debate about how to best to distribute and finance mosquito nets and insecticides (Lines, 1996) which continues today.

### **2000-2007 Emergence of LLIN technology**

In 2004 a Cochrane review on ITNs concluded that "ITNs are highly effective in reducing childhood mortality and morbidity from malaria"(Lengeler, 2004). However, nets had to be treated with insecticide every six to 12 months to maintain a level of protection that went beyond the physical barrier of the net. Even where single treatment sachets of suitable insecticide were commercially available and in areas where mosquito net use was traditional and well-established, up take was low (Kilian, A, 2013). In response to this, WHO stimulated net manufacturers to produce LLINs and by 2001, two were commercially available. WHO's Pesticide Evaluation Scheme (WHOPES) recommended Sumitomo Chemical's Olyset Net® as an LLIN for malaria control in 2001 (World Health Organization, 2001) and granted "interim recommendation" to Vestergaard-Frandsen's PermaNet® 2.0 in January 2004 (World Health Organization, 2004).

### **2007-present Push for Universal Free Access to Vector Control with LLINs**

In 2007, the WHO issued a position statement on the use of LLINs for malaria prevention (World Health Organization Global Malaria Programme, 2007). For the first time, WHO recommended that insecticidal nets be long-lasting, and distributed either free or highly subsidised (either directly or through voucher/coupon schemes) for full coverage of all people at risk of malaria, marking a shift from the focus on pregnant women and children under five years old. WHO also recommended that national malaria control programmes and their partners involved in insecticide-treated net interventions implement strategies to sustain high levels of LLIN in parallel with strategies for achieving rapid scale-up. Although WHO emphasises the role of public health services in LLIN implementation, it does not exclude the involvement of the private sector which have played and will continue to play a complementary role in implementing LLIN interventions.

## **Quantifying Sources of LLIN Demand**

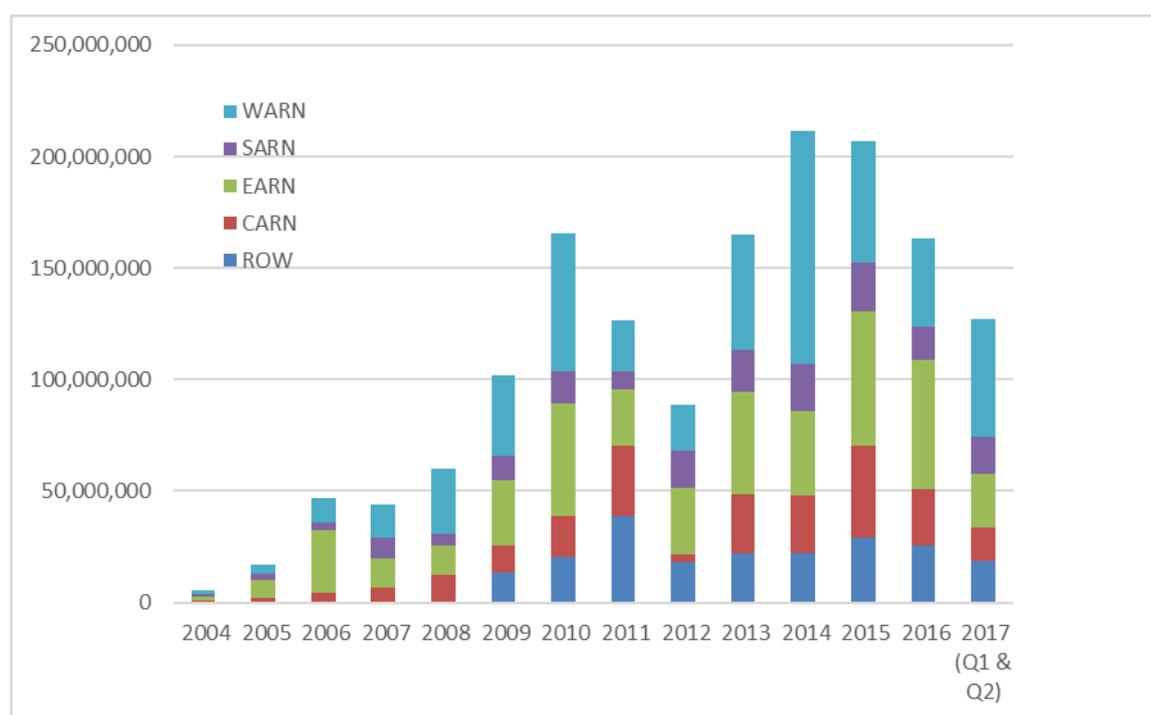
The 2007 WHO position statement on expanded coverage and universal access to LLINs for all people at risk of malaria (World Health Organization Global Malaria Programme, 2007) coupled with the UN Population Division projections for population growth (United Nations, 2017), defines a much larger target market from that agreed on in 2000. The estimated number of LLINs required to achieve coverage targets in 40 sub-Saharan African countries between 2013 and

2016 was 806 million (Paintain et al., 2013), with a forecasted 217m LLINs needed for 2017(Roll Back Malaria, 2014<sup>1</sup>).

The Alliance for Malaria Prevention’s Net Mapping Project (NMP) surveys every LLIN manufacturer each quarter and quantifies the number of nets that have been delivered to each country reporting on a worldwide, country and regional level. Our analysis of NMP data shows that reported net sales peaked at over 200 million in 2014 (Figure 2). The African region dominates global reported net sales, with the West and East African regions contributing the largest share within Sub-Saharan Africa (SSA). Outside of SSA, the largest percentage of nets going to countries in the rest of the world (ROW) between 2009 and 2017 went to India, Indonesia and Myanmar.

NMP data shows the dominance of donors who are responsible for more than 99% of global demand for LLINs in 2015, 2016 and so far in 2017. The Global Fund (GF) remains the biggest purchaser of LLINs with 62% in 2015, 45% in 2016 and 65% in 2017(to date). The US Governments’ Presidents Malaria Initiative (PMI) was the second largest donor, but has now been matched by “other donors”. Private demand accounts for less than 1%; 0.17% in 2015 which increased to 0.44% in 2016 but for quarters 1 and 2 of 2017 has decreased to 0.11%.

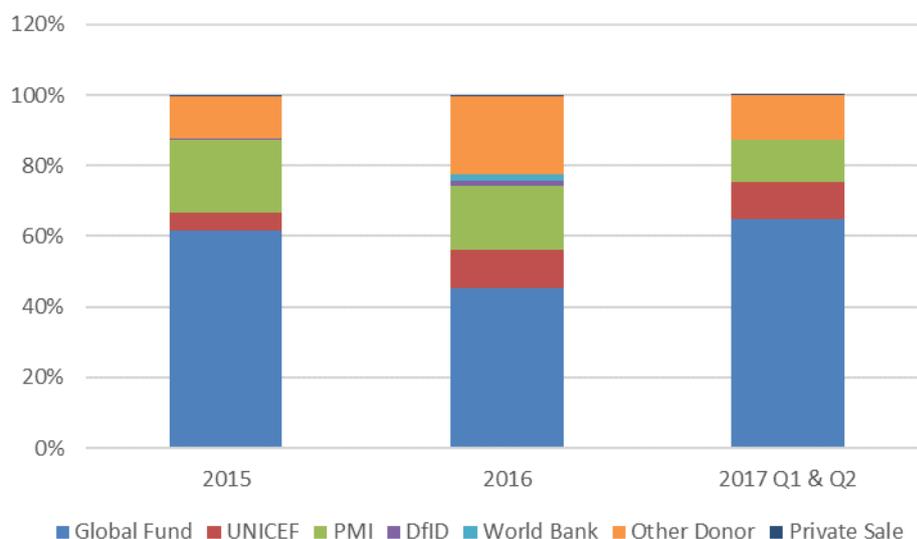
Figure 2. Net Sales by Region as Reported to Net Mapping Project 2004-2017



Source: Data from Netmapping project, figure: Authors. Regions: WARN = West Africa; SARN = Southern Africa; EARN = East Africa; CARN = Central Africa; ROW = Rest of World. Note. ROW data reporting commences in in 2009. 2017 data for Q1 and Q2 only.

<sup>1</sup> These estimates used to be updated regularly by Roll Back Malaria, however we were unable to find recent estimates, possibly due to the recent changes to the Roll Back Malaria Partnership which may have led to changes in responsibility for providing and disseminating these estimates.

Figure 3 LLIN supply by donor



Source: Data obtained from the Net Mapping Project, figure Authors. <http://allianceformalariaprevention.com/working-groups/net-mapping-project/>

The LLIN market could be described as a monopsony due to the dominance of a single major donor, the Global Fund, in the purchase of global LLINs. Over recent years procurement of LLINs has become more centralised often passing through **Global Funds Pooled Mechanism**. While this has several benefits including the ability to negotiate lower prices, pooled procurement can potentially disenfranchise national disease control programmes and may limit choice of locally specific and appropriate products. Ultimately the dominance of a single powerful buyer may be reducing the variety of products being produced, and the downward pressure on prices may at some point reduce the quality and desirability of nets for example by making them smaller or of rougher yarn. There is a potential price quality and price variety trade off in the LLIN market, both of which may ultimately reduce LLIN utilisation once products are distributed.

## Household Demand

Over the past two decades many households in Africa have become familiar with LLIN technology and it could be argued that the free distribution of LLINs has sensitised consumers to the product, creating a large potential market for the private sector. Data shows that the proportion of households with sufficient ITNs for all household members was 42% in 2015; well below universal coverage target (100%). It is estimated that 53% of the population at risk in SSA slept under an ITN in 2015, an increase from 5% in 2005 and from 30% in 2010 (World Health Organization, 2016). Even in countries that report high coverage levels, evidence suggests that there are not enough nets to cover all household members, that coverage is inequitable both between and within households, and use of LLINs is inconsistent (PMI, 2016). Further challenges include supporting delivery costs for LLINs and maintaining coverage as nets become lost or damaged and/or the household increases. However, the biggest constraint to LLIN/ITN use is access (i.e. not having any or enough to cover all family members). In other words, demand for LLINs outstrips the supply.

The retail market potentially provides households with options for replacing or increasing the number of nets they own with products that best fit their needs by supplying a variety of net

shapes, sizes and colours. Results from a recent choice experiment conducted in Tanzania exploring private demand for nets suggest that there is private demand and this could potentially supplement future coverage campaigns (Gingrich, Ricotta, Kahwa, Kahabuka, & Koenker, 2017). A key factor influencing demand was whether a participant's household currently owned sufficient nets for all members, with rural participants showing lower net coverage and greater demand than urban participants. Both poor and less poor households showed strong evidence of making purchase decisions based on more than price alone. Willingness-to-pay varied for different attributes such as rectangular shape, large size and insecticide treatment and the impact of price on demand was negative but small. The authors suggest that net manufacturers and retailers should advertise and promote consumers' preferred net attributes to improve sales and further expand net access and coverage. In addition, policy makers should consider making credit available for interested buyers.

However, it is not clear whether there is a significant market for unsubsidised LLINs outside of urban areas (Koenker et al., 2013). Internationally recognised WHOPEs-recommended LLINs are available on the Tanzanian commercial market in small quantities but these remain an insignificant portion of LLINs available in country. In addition to this there are concerns over fake LLINs and it would be virtually impossible for consumers to be sure that they had purchased a real LLIN as the insecticide is invisible and has no odour.

A new DFID funded project in Ghana – the Private Sector Malaria Project ([www.privatesectormalaria.org/](http://www.privatesectormalaria.org/))– will investigate consumer preferences for different LLIN attributes, and also conduct retail audits to establish what nets are available in commercial outlets. The ultimate aim of this project is to investigate the feasibility of using commercial markets to increase access to LLINs.

## **Demand for Other Vector Control Interventions**

The focus of this report is LLINs, although other preventative measures may need to be considered in the context of LLINs. For example, the WHO Elimination Framework recommends that all countries should aim to have the capacity to deploy Indoor Residual Spraying (IRS) on top of LLINs/ITNs but that the introduction of IRS should not be used to compensate for poor coverage of LLINs/ITNs (World Health Organization, 2017). A Cochrane Review is currently being conducted to evaluate whether IRS in combination with LLINs/ITNs causes an additional reduction to malaria transmission versus LLINs/ITNs alone (Choi, Pryce, & Garner, 2017). Global demand for IRS is dominated by financing from the US Government President's Malaria Initiative with notable involvement of private sector players in Bioko Island (**Marathon Oil**) and Ghana (**Ashanti Gold**). Households also invest significantly in mosquito control products such as coils, indoor sprays and repellents (e.g. McElroy et al. 2009) demonstrating a willingness and ability to pay for protection from mosquitoes in the absence of any public sector involvement in the market. More recently there has been a rise in interest in the role of housing improvements in providing protection against disease vectors which opens up potentially interesting avenues for private sector engagement (Tusting et al 2017). Further investigation into these alternative vector control interventions is beyond scope of this report.

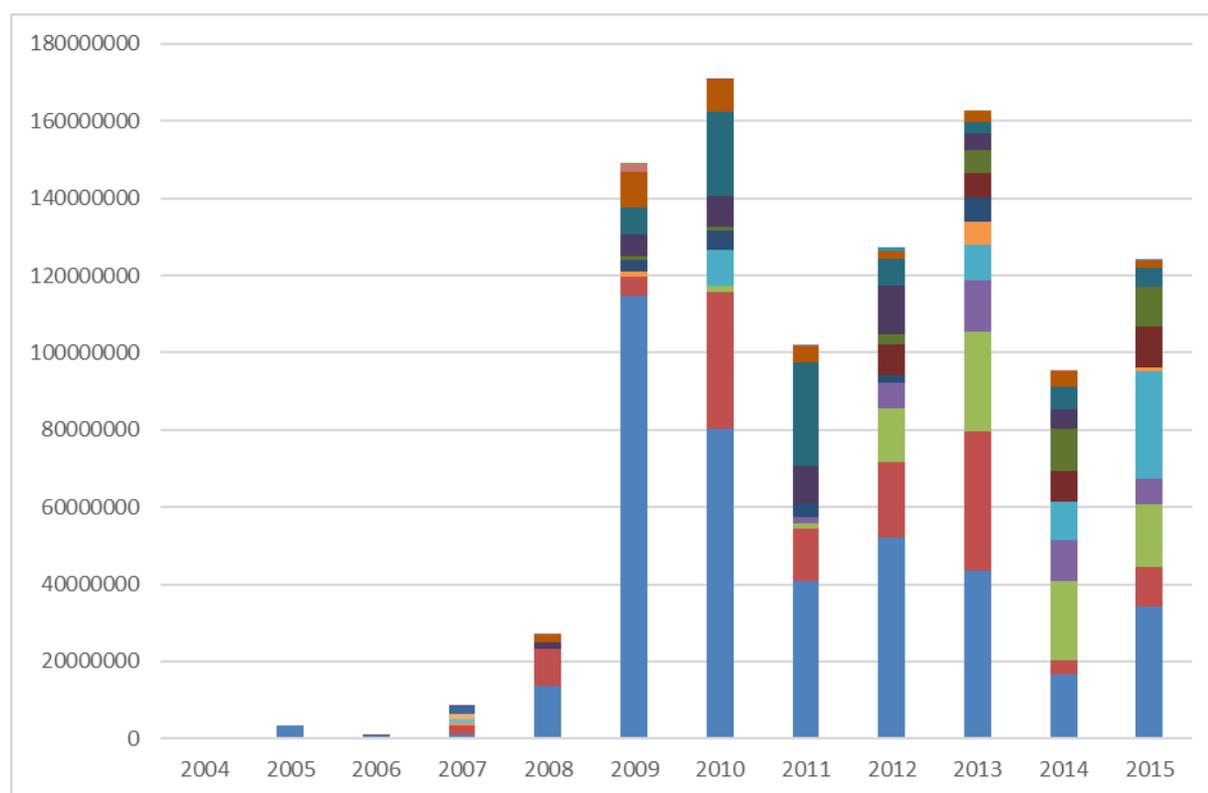
## 4. LLIN Supply Side: Production

### Competition and Market Share

The donor financed LLIN commodity market was estimated to be worth US\$1billion in 2014 (World Health Organization, 2015). Information on market share by individual producers is commercially sensitive and therefore not readily available. However, our analysis of data from the [Global Fund Price Quantity Reporting database](#) gives an indication of market share by manufacturer. Reporting to this database is voluntary and although the GF is the biggest purchaser of LLINs, crudely comparing the data from the AMP project with the data in the GF PQR database it appears that the PQR data only represents about 10% of LLIN sales in 2014 and 2015. However, GF PQR provides detailed information on net suppliers/manufacturers, prices and country. We used GF PQR data to examine the number of suppliers of LLINs and their share of the market. These data seem to illustrate a trend for both an increasing number of suppliers and a more equal share of the market over time. However, we cannot draw firm conclusions due to the incomplete nature of these data (Figure 4 and Annex 1). The AMP net mapping data is deliberately anonymised so that it is not possible to ascertain market share by manufacturers. Given the sums of donor funds invested in this market, the lack of transparency is a concern.

A further consideration is that with such a large donor market, where a single transaction can be worth millions of dollars, there is clearly the potential for the private sector to focus on a few high-volume transactions with donors, rather than try and establish complex and risky supply chains in Africa where sales volumes may be low. The private sector can utilise its pre-existing retail networks, as A to Z Textile Mills did during Tanzanian National Voucher Scheme (TNVS) (Kramer et al., 2017). However, where this pre-existing network does not already exist, it can be difficult to build, especially in hard-to-reach areas as was the case for BestNet in the TNVS. The question is whether the private sector would be more willing to invest in retail supply chains if the donor market was to shrink, or if they would simply walk away from LLIN production all together.

Figure 4 Market share by LLIN manufacturer as reported to Global Fund PQR database



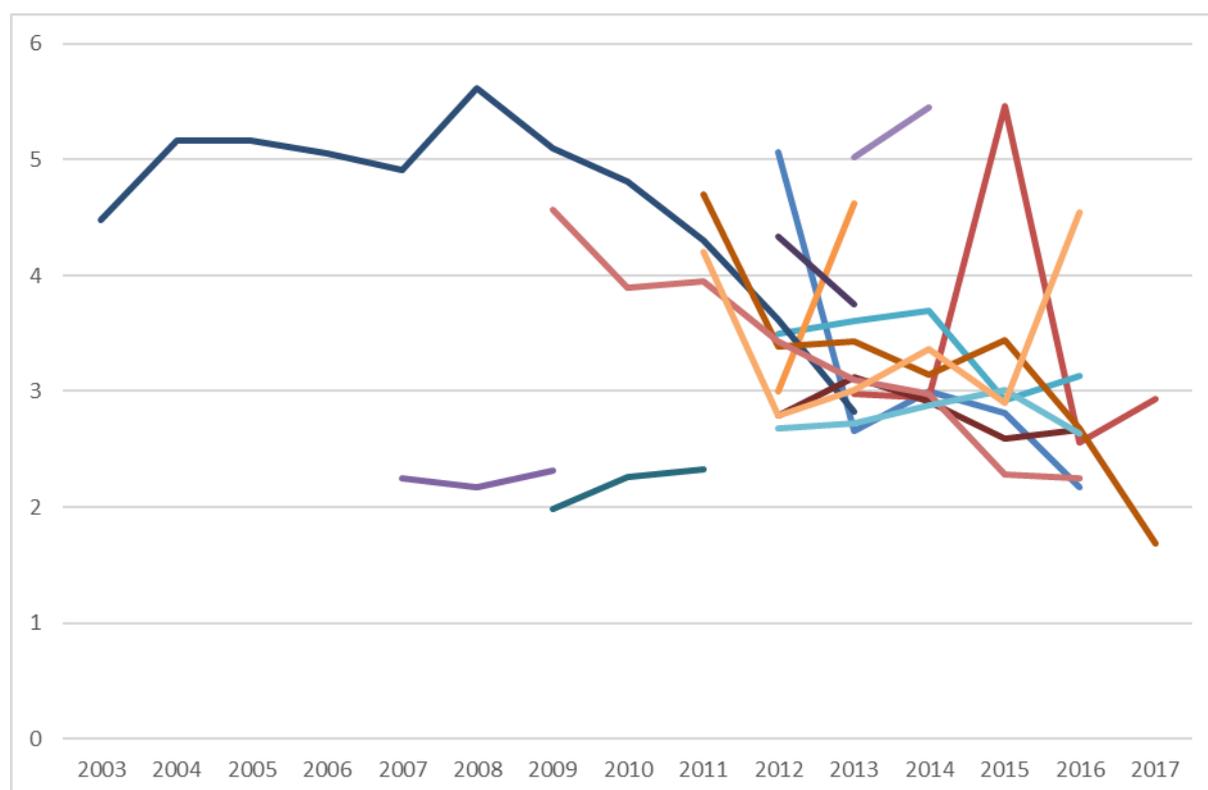
Legend: Colours represent different manufactures, too many to show clearly on figure. Blue Represents Vestergaard Group which is the biggest supplier. More detailed summaries by year shown in Annex 1

Source: Authors analysis of LLIN Market share by supplier, data obtained from Global Fund Price Quantity Reporting database Transaction Summary. [<https://bip2-ext.theglobalfund.org/analytics/saw.dll?Dashboard>] Accessed 13/07/2017.

## LLIN prices

The GF PQR data is more reliable in illustrating a downward trend in unit prices of LLINs (Figure 5). The data are supported by information from UNICEF which also shows that LLIN prices have fallen from \$4.36 in 2006, to \$1.70-2.19 in 2016 (range due to number of suppliers). This fall in prices has clearly enabled donor budgets to stretch further, but concerns have been raised about the impact of this downward price pressure on the quantity and size of LLINs, which may ultimately impact on use by households. On the other hand, the low prices and possible perceived inferiority of donor funded free nets may create an opportunity for higher quality nets to be sold via the commercial retail sector directly to country level to those who can afford them.

Figure 5 Price per LLIN for different LLIN brands 2003 – 2017, US\$ as reported to GF PQR database



Legend: Colours represent different LLIN products, too many to show clearly on figure.

Source: Authors analysis of LLIN price data obtained from Global Fund Price Quantity Reporting database Transaction Summary [<https://bip2-ext.theglobalfund.org/analytics/saw.dll?Dashboard>] Accessed 13/07/2017.

## Market Failures

### Insecticide Resistance

Currently there is only one type of insecticide (pyrethroid) being used on LLINs. It is possible that widespread use of pyrethroid LLINs is in part responsible for increasing insecticide resistance in mosquitos, thus resistance could be a negative externality of LLIN use. With insecticide resistance affecting an increasing number of malaria-endemic countries and threatening the effectiveness of pyrethroid LLINs, there is an increasing urgency to develop and implement alternative tools that control these resistant populations. One option is to provide access to ‘next-generation LLINs’ treated with two or more insecticides (combination LLINs) or with an insecticide and the synergist piperonyl butoxide (PBO LLINs). Two PBO LLINs (PermaNet© 3.0 and Olyset Plus©) are currently available on the market after receiving WHOPES interim approval under the standard LLIN categorisation in 2008 and 2012, respectively (World Health Organization, 2009, 2012). Recommendations for evaluating next-generation nets have recently been published (World Health Organization, 2014), however, at the time of writing there is no clear WHO recommendation on how these nets might potentially be used to control resistant mosquitoes. The product manufactures claim this lack of clear policy recommendation recognising the potential additional benefit of these products (and therefore may support a higher price than for standard LLINs) is a disincentive to innovation. Furthermore, a study conducted in Burkina Faso showed that “a clear WHO recommendation and adequate financing will be key to

accelerate access to next-generation LLINs” (Tesfazghi et al., 2016). This study highlights the need for increased domestic funding to reduce donor dependence and increase the power of policy-makers in Burkina Faso to choose appropriate interventions for their setting but recognises the potential need for high-level global subsidies to improve the availability and affordability of high quality products that have a higher unit cost (Tesfazghi et al., 2016)

### **Lack of Incentive to Innovate**

The lack of commercial incentives to adequately stimulate the research, development and innovation required to develop novel insecticides and vector control tools including LLINs, IRS and other approaches has been recognised. In 2005 the **Innovative Vector Control Consortium (IVCC)** was established with a US\$50 million grant from the Bill and Melinda Gates Foundation. It is a product development partnership whose aim is to stimulate industry and academia to develop new tools to manage insect disease vectors. Since 2005 IVCC has received additional funding from UK, Swiss and American tax payers, representing a public subsidy to vector control. So far, investments in malaria research via IVCC and research initiatives have resulted in a plethora of new approaches to control disease vectors (Killeen et al 2017). Those which involve the use of pesticides include; various new types of mosquito net which are currently under review for approval by WHO and notably one re-purposed non-pyrethroid insecticide, Actellic CS, that can be used to give long lasting protection via indoor residual spraying (IRS).

### **Barriers to Entry, Monopoly and Regulation**

There are barriers to entry for private sector manufacturers wanting to enter the LLIN market. Alongside the usual issues of cost and risk of investing in factories, capital equipment and labour, potential entrants need to ensure that their products meet the required quality standards and obtain relevant WHO approval in order to enter the large donor driven LLIN market. Prior to October 2016 the WHO Pesticide Evaluation Scheme (WHOPES) was responsible for establishing guidelines for safety and efficacy and review and recommendation of LLIN products. It has become a gold standard because donors purchase WHOPES-recommended LLINs almost exclusively. Between 2001 and 2006, only two products received a WHOPES recommendation, creating an effective duopoly. Between 2004 and 2006, Vestergaard-Frandsen and Sumitomo Chemical were awarded the vast majority of government contracts for net distribution. Sumitomo sold about 30-million Olysets, and Vestergaard sold more than 100 million PermaNets<sup>2</sup>. As of 2017 there are there are 19 WHOPES approved LLINs made by 14 different manufacturers (Table 1).

Another noticeable issue is that except for A-Z factory in Tanzania, none of the WHOPES approved LLINs are manufactured in Africa. Most production takes place in Asia. Tanzania is unique in that Sumitomo Chemical in Japan transferred in 2003 its LLIN (Olyset®) manufacturing technology to A to Z Textile Mills Ltd in Arusha, Tanzania, a local producer already engaged in the manufacturing of bed nets, as a royalty-free transfer (Gradl, 2013). Transfer of LLIN production to endemic countries potentially creates economic benefits in the form of tax revenues and jobs which may encourage domestic governments to support scale up of LLINs with domestic resources (Tesfazghi et al 2016). However, experts consulted for this review suggested that the cost of establishing LLIN production capacity in Tanzania, the comparative advantage of

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<sup>2</sup> <http://www.fightingmalaria.org/issues/insecticide-treated-nets-5.html>. Accessed 25/07/2015

Asia over African in supporting manufacturing and the limited return on the investment meant that this is unlikely to be reproduced in other countries. Others suggested that there may be a role for transferring the stitching of nets to Africa using imported LLIN materials, however there are issues related to taxes and tariffs on imported netting that would need to be addressed to make this economically feasible.

Table 1 WHOPES approved LLIN products as of June 2017

<b>Product Name</b>	<b>Product description</b>	<b>Manufacturer</b>	<b>Recommendation</b>
<b>DawaPlus 2.0</b>	Deltamethrin coated on polyester	Tana Netting	Interim
<b>DawaPlus 3.0</b>	Combination of deltamethrin coated on polyester (side panels),and deltamethrin + PBO incorporated into polyethylene (roof) and deltamethrin + PBO incorporated into polyethylene (roof)	Tana Netting	Interim
<b>DawaPlus4.0</b>	Deltamethrin + PBO incorporated into polyethylene	Tana Netting	Interim
<b>Duranet</b>	Alpha-cypermethrin incorporated into polyethylene	Duranet LLIN	Full
<b>Interceptor</b>	Alpha-cypermethrin coated on polyester	BASF	Full
<b>Interceptor G2</b>	Alpha-cypermethrin and chlorfenapyr coated on polyester	BASF	Interim
<b>LifeNet</b>	Deltamethrin incorporated into polypropylene	Bayer	Interim
<b>MAGNet</b>	Alpha-cypermethrin incorporated into polyethylene	V. K. A Polymers LTD	Full
<b>MiraNet</b>	Alpha-cypermethrin incorporated into polyethylene	A - Z Textile Mills Tanzania	Interim
<b>Olyset Net</b>	Permethrin incorporated into polyethylene	Sumitomo Chemical Company	Full
<b>Olyset Plus</b>	Permethrin + PBO incorporated into polyethylene	Sumitomo Chemical Company	Interim
<b>Panda Net 2.0</b>	Deltamethrin incorporated into polyethylene	Life Ideas Textiles, China	Interim
<b>Permanet 2.0</b>	Deltamethrin coated on polyester	Vestergaard Frandsen	Full
<b>Permanet 3.0</b>	Combination of deltamethrin coated on polyester with strengthened border (side panels), and deltamethrin + PBO incorporated into polyethylene (roof)	Vestergaard Frandsen	Interim
<b>Royal Sentry</b>	Alpha-cypermethrin incorporated into polyethylene	Disease Control Technologies Ltd	Full
<b>SafeNet</b>	Alpha-cypermethrin coated on polyester	Mainpol GmbH	Full
<b>Veeralin</b>	Alpha-cypermethrin + PBO incorporated into polyethylene	Vector Control Innovations Pvt Ltd, India	Interim

<b>Yahe</b>	Deltamethrin coated on polyester	Fujian Yamei Industry, China	Interim
<b>Yorkool</b>	Deltamethrin coated on polyester	Yorkool International Co., Ltd.	Full

Source: [http://www.who.int/whopes/Long-lasting\\_insecticidal\\_nets\\_June\\_2017.pdf?ua=1](http://www.who.int/whopes/Long-lasting_insecticidal_nets_June_2017.pdf?ua=1)

Following criticism about the time taken by WHOPES to review submissions, the process of obtaining WHO approval for vector control products, including LLINs, has recently been changed to streamline and accelerate the process. The WHOPES process is currently being phased out, though products already under review will remain under the WHOPES process and products with existing WHOPES approvals will be converted to pre-qualification (PQ) upon submission of a satisfactory conversion package, factory standards and product quality checks over the next five years. Vector control products submitted for review after October 2016 will be subject to a new process. The process is different depending on whether a product is deemed to belong to a product class with a product claim for which a WHO policy recommendation has been issued or not. If it does (e.g. it is a pyrethroid LLIN) then it will enter the prequalification pathway which requires submission of a product dossier which includes data and information to support the safety, efficacy, and quality requirements appropriate to the product type and generated according to Good Laboratory Practices (GLP) and appropriate Quality Management System (QMS). This dossier is reviewed and if complete the dossier will be reviewed by an expert panel and manufacturing facilities will be inspected to ensure compliance with WHO quality standards. If the panel is satisfied and the required factory standards are met, then it will be listed on the WHO PQ website (<http://www.who.int/pq-vector-control/en/>) and can be procured using UN funds.

The process for products which are not deemed to belong to a class that already has WHO policy recommendation is managed by the WHO Vector Control Advisory Group (VCAG). VCAG guides innovators in data and documentation requirements, and advises WHO on the public health value of new tools, technologies and approaches. This advisory group was jointly established by the Global Malaria Programme and the Department of Control of Neglected Tropical Diseases. Products belonging to a class and/or having a product claim (or claims) for which there is no applicable WHO policy recommendation will be referred to VCAG. For each new product class or variant not yet recognized by WHO and for which there is no WHO policy recommendation (1), VCAG will provide a recommendation to WHO on the evidence required to substantiate the claim(s) and will advise on the evaluation methods needed to generate these data. VCAG's role will depend on how advanced the evidence is to support a new vector control tool, technology or approach. These products are assessed for their potential public health value, which will require epidemiological data on their protective efficacy against infection and/or disease. This implies the need for data from large scale implementation and/or randomised control trials. If this is the case the process is likely to take upwards of 2-3 years to gather evidence required by VCAG to make a recommendation to WHO. VCAG is also responsible for assessing products which are classed as those exhibiting variations of claims for an existing product class for example LLINs that claim to control insecticide resistant mosquitoes. Further details of the evaluation process for vector control products can be found in this WHO information note (WHO, 2017).

There are two key market concerns related to the process for approving new vector control tools, which includes modified LLINs that are likely to affect the private sector involvement in the production of LLINs. The first is about the cost and time required to bring new technologies to

market which under the new process must be met by manufacturers of the product. This process inevitably involves a risk that the product will fail meaning a loss of sunk investment costs. Even if a product is proven to be effective, there is still uncertainty about the demand for the products which may be dependent on donor funding that is subject to political uncertainty in donor countries and/or on uncertain consumer demand. The other issue is that under the new model, innovators bear the cost and risk of failure, but once a product has a proven claim and WHO recommendation, other manufacturers can enter the market via the quicker and less risky PQ process. This erodes the potential gains to be made from innovation and encourages “free riders” to produce so-called copycat or “me too” products with lower cost and less risk which creates the potential to undercut the innovators product. While lower costs are a potentially good outcome, challenges such as insecticide resistance and the need to provide a variety of products that respond to changing vector behaviour and consumer tastes and preferences also require innovation.

There is an apparent trade off here between greater competition leading to lower product prices that in turn translate to higher numbers of LLINs for a given budget on the one hand, and less competition leading to higher product prices and fewer LLINs for a given budget. Furthermore, the incentive to innovate is potentially reduced in a market where the returns generated by innovation are lower due to low prices and subject to an increased risk of being competed away by new market entrants, so lower barriers to entry may inadvertently suppress product innovation.

## 5. LLIN Supply Side: Distribution

### Catch-up and Keep-up LLIN distribution

Long-term protection with LLINs is dependent on achieving and maintaining high coverage of the overall population. Distribution requires two integrated strategies: (1) a **‘catch-up’ strategy** that allows a fast increase in the coverage of LLINs in the country, and which is usually achieved by free mass distribution campaigns; and (2) a **‘keep-up’ strategy** to maintain a high net coverage through the continuous provision of nets which can involve provision through health facilities, routine antenatal care or immunization services, schools and the private sector. The keep-up strategy needs to run in parallel with catch-up campaigns owing to coverage gaps through net deterioration, loss of nets and population growth. LLINs also need replacing every three years. Both strategies should be supported by behaviour change communication campaigns (Roll Back Malaria, 2012).

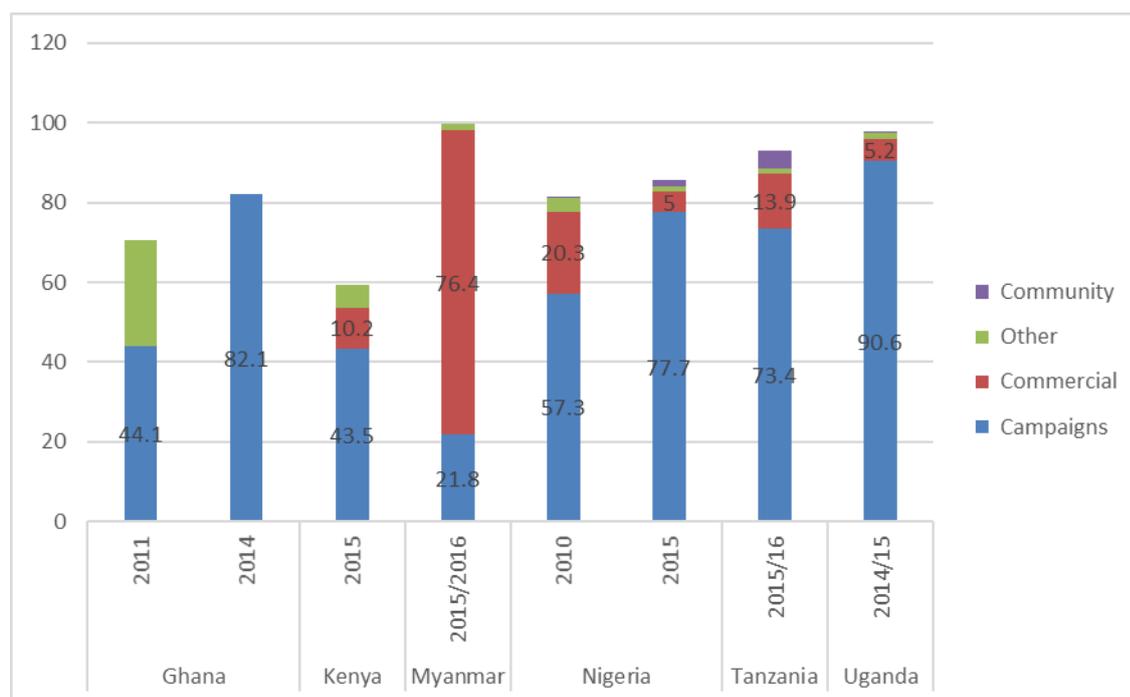
In Africa, the most common catch-up strategy at present involves mass procurement of LLINs by African governments using donor finances (notably the Global Fund) and free-at-the-point-of-delivery distribution to end users by the National Malaria Control Programme (NMCP) and partners through regular (three years) campaigns. Keep-up strategies tend to have similar procurement and financing, with distribution being coordinated by NMCPs using systems such as antenatal care, expanded programme on immunisation or various community based models (e.g. community health workers or volunteers).

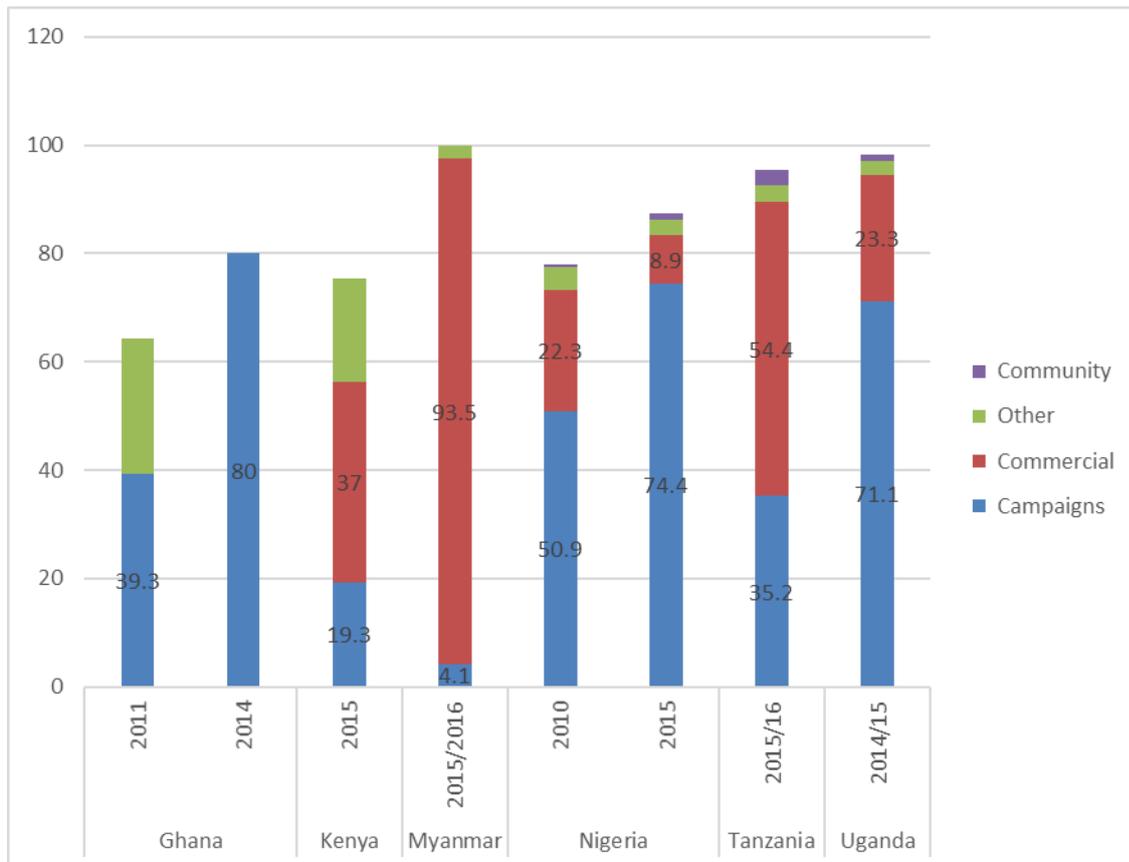
In some contexts, retreatment programmes are still important for untreated bednets, particularly in Vietnam where donors have supplied untreated bednets. However, in Africa, LLIN technology dominates.

## Public and Private Sector Distribution channels

To estimate the contribution of different distribution systems to net coverage we reviewed recent Demographic and Health Survey (DHS) and Malaria Indicator Survey (MIS) reports for selected African countries: Ghana, Kenya, Nigeria, Tanzania and Uganda. We also included the only South East Asian country that we could obtain data for, Myanmar. Conducting a separate analysis for rural and urban areas showed that in SSA the majority of people with nets got them from campaigns with commercial sources of nets being lower. Commercial sources of net were generally higher urban areas, Tanzania (54%), Kenya (37%) and 23% in Uganda. Almost all the urban nets in Myanmar were from commercial sources (93.5%) with 76% coming from commercial sources in rural areas. Two countries had more than one survey. In Nigeria the commercial source of net declined between surveys, in Ghana commercial sources of net were not classified separately in the data. These data have to be interpreted with caution as surveys only provide a snapshot, and without contextual information notably on the timing of the data collection in relation to any mass distribution campaigns we cannot understand the dynamics of sources of nets. Also it's not clear if these nets are untreated nets, ITNs and LLINs which may well vary between distribution systems.

Figure 6 Source of LLINs/ITNS from selected MIS and DHS survey reports Rural (top) and Urban (bottom)





Source: Data extracted by authors from MIS (<http://www.malariasurveys.org/>) and DHS reports. (<http://www.dhsprogram.com/publications/publication-search.cfm?type=5>)

## Lessons from South East Asia

While the private sector in Asia plays a bigger role in distributing mosquito nets than it does in Africa, there are many important reasons for this and differences between Asia and Africa which may make it difficult to draw any useful lessons. Historically nets were widely used in Asia before the 1990s/2000s scale up so the private sector was already there delivering nets at scale. In contrast in many parts of Africa there was no tradition of net use prior to public net distribution. The main policy for malaria control in most Asian countries is vector control, but frequency of mass campaign distribution is a lot less than in Africa and donor funded distribution of nets in Asia has been on a much smaller scale than in Africa, hence the potential for crowding out of the private sector has been far less. Also, countries like Viet Nam continue to be involved in community retreatment of nets, which is seldom found in Africa after 2005 primarily due to challenges with feasibility of conducting retreatment. In Myanmar, implementation strategies include free delivery of LLINs and free treatment of mosquito nets already in use before the start of the peak transmission season (Liu et al 2015). The fact that treatment of nets is feasible in Asia, means that consumers can purchase lower priced untreated nets and the public sector can focus on paying for insecticide to turn these products into a public health intervention. The economic context is also very different, with Asian countries generally being wealthier than African ones making affordability less of a constraint. At the same time since most nets are manufactured in Asia, the costs of supplying the Asian market are lower. If any lesson can be drawn from Asia, it is probably that in parts of Africa where there is a culture of net use, and where affordability is not a challenge (perhaps urban areas and/or more wealthy countries)

people will purchase nets from the private sector. However, given that retreatment programmes are unlikely to be feasible in these contexts, that consumers may not be willing to pay a premium for LLINs and/or are at risk of being sold fake LLINs, it is not clear how to turn the purchase of nets into a public health good.

## Targeted Subsidies

While free market systems (with or without donor support) can achieve some levels of net coverage, this tends to be skewed towards wealthier and urban populations. In the 1990s debate was hot about whether LLINs should be fully or partially subsidised and whether and how subsidies should be targeted. On the one hand those in favour of a full subsidy said that it was unfair and inequitable for the world's poorest people to be asked to contribute to the cost, whereas those in favour of a partial subsidy were concerned about sustainability. They feared that fully subsidised products would crowd-out the private sector which in some countries had been effectively distributing untreated bed nets without public subsidy, and that over the long term, donor fatigue would lead to a decline in subsidised net distribution and destruction of private distribution. Several demand side voucher schemes were implemented to provide a way of subsidising the price paid by consumers (often pregnant women and children) without bypassing (crowding out) the private sector distribution mechanism. The most well-known of these schemes, the Tanzanian National Voucher Scheme was launched in 2004. Here we briefly describe the voucher scheme adopted in Tanzania, and the challenges this scheme faced, and the voucher scheme that was planned to be adopted in Ghana and enabling differences between the two countries.

## Tanzanian National Voucher Scheme

The Tanzanian National Voucher Scheme (TNVS) represents one of the largest and most enduring keep-up programmes targeting pregnant women and young children in any endemic country and the only national level voucher scheme to distribute nets. The TNVS started in October 2004 and reached national scale by in 2006. The TNVS was a public-private partnership (PPP) under the leadership of the Ministry of Health, and included multilateral and bilateral development partners, NGOs, academic institutions, mosquito net manufacturers, wholesalers and retailers. Funding for the programme was provided by The Global Fund from 2003 to 2011, USAID (through PMI) from 2006 to 2013 and DFID from 2011 to 2014.

From October 2004 to mid-2014 the TNVS was the key distribution mechanism under the National Insecticide Treated Nets (NATNETS) Programme to increase access to and use of ITNs and from 2009 LLINs amongst pregnant women and young children. These two target groups were issued with a discount voucher when attending a reproductive and child health facility. The vouchers could then be exchanged for an ITN or LLIN at a participating retail outlet at a greatly reduced price. The initial aim was to increase coverage of ITNs to 60% amongst pregnant women and infants and to develop a strong commercial supply chain for nets supplemented by subsidised sales to target population. In 2007 the TNVS introduced two changes to its operations by increasing the amount to 3250 TSh (which only partly compensated for higher retail ITN prices, arising in part from oil price increases) and adding a new voucher for infants. In 2008, the NMCP launched a national 'catch-up' campaign to distribute free LLINs to all children under 5 years old. In 2014, the TNVS closed due to the end of donor funding, exposure of fraudulent activities in the e-voucher mechanism by some clinic and retail staff and over issuing of infant vouchers, contrary to policy. The TNVS provided the framework for a commercial retail market

but since the programme was closed there has been limited incentive for retailers to stock LLINs. Cheaper, untreated nets are still widely available in urban and peri-urban areas – so there is still a demand if the price is right.

Kramer et al. 2017 examined the effectiveness and equity of the TNVS as the programme evolved (Kramer et al., 2017). The effectiveness of the TNVS was a function of several interdependent factors including, the supply chain of vouchers through the public health system; the supply chain of nets in the commercial sector; the demand for nets from voucher recipients; management and risk mitigation measures; and the influence of the global and donor objectives. The programme reached most beneficiaries with vouchers and provided 1.2 million to 1.8 million highly subsidised LLINs per year. Approximately 30% of all (long lasting) insecticide treated nets between 2004 and 2014 were distributed through TNVS. The authors hail the TNVS as “a unique, innovative and globally influential programme that stimulated strategic thinking about effectively and equitably distributing ITNs, and contributed directly to the evolution of global LLIN policy”. The TNVS maintained for some years a nationwide retail network which formed the downstream end of the LLIN supply chain but was unable to strengthen the commercial supply chain for nets supplemented by subsidised sales to target populations. In spite of a decade of donor funding and three distinct programme design models, a commercial market for LLINs was never established in Tanzania for multiple interconnected reasons including: challenges of establishing a retail network in hard-to-reach areas; poor mobile phone connectivity which hampered enrolment of retailers to the e-voucher scheme; LLIN stock outs; and the high retail price of LLINs coupled with low profit margins for retailers (Kramer et al., 2017).

Reliance on external funding made the TNVS vulnerable in several ways (Kramer et al., 2017). Key changes in global malaria policy from 60% coverage amongst pregnant women and infants with ITNs to free universal coverage with LLINs removed (donor) focus on the private sector as a distributor (Kramer et al., 2017). This policy change also narrowed the scope for private sector players in the production of nets, as only the ones who had the technology to produce LLINs (as opposed to ITNs) could participate in the donor funded net market. This meant that Tanzania had a reliable domestic supplier of LLINs, which transpired to be important for multiple reasons:

1. It brought with it an established wholesale/retail supply chain to get nets to urban, and peri urban areas successfully (less well to rural hard-to-reach areas) thus facilitating the voucher scheme with a distribution chain (Gradl, 2013).
2. The domestic LLIN manufacturer endured after a new international entrant (NetProtect®, made by BestNet) to the market failed to establish adequate distribution networks, and then had its WHOPES recommendation revoked as the required field studies were found not to comply with the WHO requirement for testing and evaluation of LLINs (Gradl, 2013).
3. The domestic manufacture of LLINs provided powerful local champions who helped drive the agenda, and the fact that there were domestic economic returns to the Tanzanian government in the form of jobs and tax revenues which helped to provide an enabling environment to continue to support this public private model even against the direction of global policy.

The sustainability of A to Z's Olyset® production was challenged by the complex linkages between donors, governments, companies, and end-users. A to Z found itself in a position where the Olyset® nets had to compete with less effective and less expensive LLINs manufactured in Asia that had only achieved “interim” WHOPES certification (Brigham and Women's Hospital,

April 2011). Additionally, donors' long-established shipping and distribution networks for bed nets manufactured in Asia were preventing A to Z from capitalizing on its relative proximity to most of the world's malarious regions. Frustratingly, donors and development organizations (bilateral and multilateral) required bed net manufacturers to quote prices exclusive of distribution and delivery costs, negating the advantage of A to Z's local manufacture (Brigham and Women's Hospital, April 2011).

The PPP model harnessed by the TNVS was more successful in its earliest phase i.e. when distributing vouchers for ITNs, where there were multiple suppliers and prices were relatively low (before universal free access to LLINs policy goal). Introduction of LLINs to the TNVS with the subsequent reduction in the number of producers and increase in costs and prices, contributed to a much lower coverage and uptake of the programme. Equity of access to LLINs and a viable private market was not achieved but the programme did contribute significantly to "keep up" of LLIN coverage by harnessing the private sector, especially in terms of retail supply chains. Kramer et al (2017) suggest lessons learned from the programme include:

- The need to simultaneously address supply side (number of suppliers, reach of supply chain, quality standard of product) and demand side (access, affordability and availability of variety of nets to meet diverse demands) which results in a complex programme design;
- The challenges of preventing fraud and providing donors reassurance that funds are being used for their intended purpose.
- Vulnerability caused by changing donor priorities.

## **Ghanaian Voucher Scheme**

In Ghana, national-scale implementation of vouchers never progressed beyond discussion and piloting towards formulation of policy; the approach was replaced by mass distribution campaigns with less dependency on or integration with the health system. By 2011, Ghana entered a phase with no publicly support continuous delivery system for ITNs. A study reported in 2012 found that contextual factors which provided an enabling environment for the voucher scheme in Tanzania did not do so in Ghana. The voucher scheme was never seen as an appropriate national strategy, other delivery systems were not complementary and the private sector was under-developed (de Savigny et al., 2012). The engagement and consensus building among all stakeholders and public sector support of the private sector in Tanzania was an enabling difference to Ghana which suffered competition from delivery systems (de Savigny et al., 2012). Key messages from this paper include:

- Contextual requirements for the success of an intervention should be considered before an intervention is picked from one context and piloted in another.
  - Stakeholder engagement and management is critical for ownership and sustained integration of the intervention in the system.
  - Alignment of partners and efforts behind a single delivery strategy for an intervention results in less complexity and unpredictability in how the system will react.
- (de Savigny et al., 2012)

## 6. Lessons and Key Questions

There appears to be a renewed interest in engaging, expanding and diversifying the private sector's role in the production and distribution of LLINs. This is in part due to the shortfall in funding required to provide universal coverage of LLINs and the decline in donor funding of malaria that we have seen over the past years. It is also a question that was widely researched and debated 10-15 years ago, when concerns over financing, equity and sustainability of ITN coverage were also highly topical. While much of the empirical evidence from this time will be irrelevant now, the key lessons remain highly relevant. For example, in 2005, Magesa et al. describe Tanzania's experience in promoting the development of a commercial sector for insecticide-treated nets; before the global policy of universal coverage with LLINs (Magesa et al., 2005). The authors suggest that neither the public sector nor the commercial sector alone can achieve universal coverage with mosquito nets, but that the best way forward is a well-coordinated partnership among all mosquito net stakeholders based on increased demand and supply, a vibrant commercial sector, and a targeted subsidy scheme for those most at risk (Magesa et al., 2005). To create and sustain this partnership, a shared vision is required along with a number of enabling factors including: (1) removal of any form of taxation; (2) favourable insecticide regularity conditions; (3) net quality control issues; (4) generic demand creation by the public sector; and (5) equity of access (Magesa et al., 2005).

Household demand is a key factor influencing the choice of delivery strategy. It is not clear whether there is a significant market for unsubsidised LLINs outside urban areas. Internationally recognised WHOPES-recommended LLINs are available on the Tanzanian commercial market in small quantities but these remain an insignificant portion of the LLINs available in country (Koenker et al., 2013). This is likely to be due to affordability and a lack of awareness about the difference between nets and LLINs. However, it could also suggest that free or highly subsidised LLINs dampen demand for commercial nets. Further research is required to determine whether it is possible to combine free nets delivered through mass campaigns with a system which relies on the commercial sector to distribute nets, and to determine whether the coverage achieved through this combined system is more sustainable than that which any one system can achieve on its own.

A recently launched DFID funded project, the Private Sector Malaria Prevention (PSMP) project (previously mentioned) aims to find out the extent to which private sector can be encouraged to increase participating in financing and delivery of malaria control in Ghana by focusing on three main areas: retail supply chain and demand creation, workplace programs and advocacy. The CCP are currently conducting a market analysis in Ghana and Tanzania looking at consumer preferences, willingness to pay, market size and other factors that they will share with international bed net manufacturers. This project will provide useful up to date data to supplement the historical ITN and net market analyses that exist.

Quantifying the economic burden of malaria may convince businesses that it is economically beneficial to invest in malaria control, generating additional financing. A study in Ghana found that businesses in Ghana lost about US\$6.58 million to malaria in 2014, 90 % of which were direct costs. A total of 3913 workdays were lost due to malaria in firms in the study sample during the period 2012–2014. Importantly, 93% of business leaders expressed the need for private sector investment in malaria control in Ghana; a country where donor funds are reducing due to the country's status as a lower-middle income country (Nonvignon et al., 2016).

The recent demise of the longest running targeted subsidy scheme in Tanzania is a clear setback in efforts to creatively engage the private sector in the supply of affordable and high quality mosquito nets. However, it also provides important lessons on how to conduct these programmes should appetite for them return. The main lesson seems to be that any public private partnership will require strong management and robust strategies to prevent abuse, this will cost money to achieve and will need to be maintained. Engaging the private sector should not be seen as a way to reduce the costs of protecting people with LLINs, but rather as an opportunity to increase coverage, reduce inefficiencies and stimulate innovation in new effective products that consumers demand and are willing to pay for. But there is a balancing act between supporting the existing private sector players, and ensuring that barriers to entry for new players are kept low to improve competition. This is a complex public policy challenge.

## 7. References

- AngloGold Ashanti: <http://www.anglogoldashanti.com/en/Media/Our-Stories/Pages/Creating-a-sustainable-solution-for-malaria-in-Continental-Africa-Region.aspx>
- Bhatt, S., Weiss, D.J., Cameron, E., Bisanzio, D., Mappin, B., Dalrymple, U., Battle, K., et al. (2015). The effect of malaria control on *Plasmodium falciparum* in Africa between 2000 and 2015. *Nature*, 526(7572): 207-211
- Brigham and Women's Hospital. (April 2011). *Building Local Capacity for ealth Commodity Manufacturing: A to Z Textile Mills Ltd*. Retrieved from
- Choi, L., Pryce, J., & Garner, P. (2017). The combination of indoor residual spraying with insecticide-treated nets versus insecticide-treated nets alone for preventing malaria. *Cochrane Database of Systematic Reviews*(6). doi:10.1002/14651858.CD012688
- D'Alessandro, U., Olaleye, B. O., McGuire, W., Thomson, M. C., Langerock, P., Bennett, S., & Greenwood, B. M. (1995). A comparison of the efficacy of insecticide-treated and untreated bed nets in preventing malaria in Gambian children. *Trans R Soc Trop Med Hyg*, 89(6), 596-598.
- Darriet, F., Robert, V., Tho Vien, N., & Carnevale, P. (1984). *Evaluation of the efficacy of permethrin - impregnated intact and perforated mosquito nets against vectors of malaria*. Retrieved from [http://apps.who.int/iris/bitstream/10665/65908/1/WHO\\_MAL\\_84.1008.pdf](http://apps.who.int/iris/bitstream/10665/65908/1/WHO_MAL_84.1008.pdf)
- de Savigny, D., Webster, J., Agyepong, I. A., Mwitwa, A., Bart-Plange, C., Baffoe-Wilmot, A., . . . Lengeler, C. (2012). Introducing vouchers for malaria prevention in Ghana and Tanzania: context and adoption of innovation in health systems. *Health Policy Plan*, 27 Suppl 4, iv32-43. doi:10.1093/heapol/czs087
- Gingrich, C. D., Hanson, K. G., Marchant, T. J., Mulligan, J. A., & Mponda, H. (2011). Household demand for insecticide-treated bednets in Tanzania and policy options for increasing uptake. *Health Policy Plan*, 26(2), 133-141. doi:10.1093/heapol/czq027
- Gingrich, C. D., Ricotta, E., Kahwa, A., Kahabuka, C., & Koenker, H. (2017). Demand and willingness-to-pay for bed nets in Tanzania: results from a choice experiment. *Malar J*, 16(1), 285. doi:10.1186/s12936-017-1929-2
- Goodman, C. A., Coleman, P. G., & Mills, A. J. (1999). Cost-effectiveness of malaria control in sub-Saharan Africa. *Lancet*, 354(9176), 378-385.
- Gradl, C. (2013). *Sumitomo Chemical and the Fight Against Malaria Using Bednets: A Case Study*. Retrieved from
- Kilian, A. (2014). *Comprehensive strategy for sustaining universal coverage with LLIN and the potential of the commercial LLIN market in Tanzania. Part 2: Options for LLIN market strengthening*.
- Kilian, A. (2013). *Insecticide treated nets: Balancing the roles of the commercial and public sectors. Case study of three countries in sub-Sahara Africa, Malaria Consortium Learning Paper Series: [www.malariaconsortium.org/pages/learning-papers.htm](http://www.malariaconsortium.org/pages/learning-papers.htm)*

- Killeen, G. F., Tatarsky, A., Diabate, A., Chaccour, C. J., Marshall, J. M., Okumu, F. O., ... & Tusting, L. S. (2017). Developing an expanded vector control toolbox for malaria elimination. *BMJ global health*, 2(2), e000211.
- Koenker, H. M., Yukich, J. O., Mkindi, A., Mandike, R., Brown, N., Kilian, A., & Lengeler, C. (2013). Analysing and recommending options for maintaining universal coverage with long-lasting insecticidal nets: the case of Tanzania in 2011. *Malar J*, 12, 150. doi:10.1186/1475-2875-12-150
- Kramer, K., Mandike, R., Nathan, R., Mohamed, A., Lynch, M., Brown, N., . . . Lengeler, C. (2017). Effectiveness and equity of the Tanzania National Voucher Scheme for mosquito nets over 10 years of implementation. *Malar J*, 16(1), 255. doi:10.1186/s12936-017-1902-0
- Lengeler, C. (2004). Insecticide-treated bed nets and curtains for preventing malaria. *Cochrane Database Syst Rev*(2), CD000363. doi:10.1002/14651858.CD000363.pub2
- Lines, J. (1996). Mosquito nets and insecticides for net treatment: a discussion of existing and potential distribution systems in Africa. *Tropical Medicine & International Health*, 1(5), 616-632. doi:10.1111/j.1365-3156.1996.tb00087.x
- Liu H, Xu J, Guo X, et al. Coverage, use and maintenance of bed nets and related influence factors in Kachin Special Region II, northeastern Myanmar. *Malaria Journal*. 2015;14:212. doi:10.1186/s12936-015-0727-y.
- Magesa, S. M., Lengeler, C., deSavigny, D., Miller, J. E., Njau, R. J., Kramer, K., . . . Mwitia, A. (2005). Creating an "enabling environment" for taking insecticide treated nets to national scale: the Tanzanian experience. *Malar J*, 4, 34. doi:10.1186/1475-2875-4-34
- Marathon Oil Corporation News.  
[http://www.marathonoil.com/News/Spotlight\\_Series/Bioko\\_Island\\_Malaria\\_Control\\_Project\\_A\\_Decade\\_of\\_LifeSaving\\_Results/](http://www.marathonoil.com/News/Spotlight_Series/Bioko_Island_Malaria_Control_Project_A_Decade_of_LifeSaving_Results/)
- McElroy, B., Wiseman, V., Matovu, F., & Mwengee, W. (2009). Malaria prevention in north-eastern Tanzania: patterns of expenditure and determinants of demand at the household level. *Malaria Journal*, 8(1), 95.
- Nonvignon, J., Aryeetey, G. C., Malm, K. L., Agyemang, S. A., Aubyn, V. N. A., Peprah, N. Y., . . . Aikins, M. (2016). Economic burden of malaria on businesses in Ghana: a case for private sector investment in malaria control. *Malaria Journal*, 15(1), 454. doi:10.1186/s12936-016-1506-0
- Paintain, L. S., Kolaczinski, J., Renshaw, M., Filler, S., Kilian, A., Webster, J., . . . Lynch, M. (2013). Sustaining fragile gains: the need to maintain coverage with long-lasting insecticidal nets for malaria control and likely implications of not doing so. *PLoS One*, 8(12), e83816. doi:10.1371/journal.pone.0083816
- PMI ITN Access and Use Report 2016, Hannah Koenker and Emily Ricotta. April 6 2016, Vector Works/CDC/USAID PMI
- Roll Back Malaria Commodity Gap Analysis, December 2014, Accessed 21/07/17 [www.rollbackmalaria.org/files/files/partnership/wg/.../December2014gapanalysis.pdf](http://www.rollbackmalaria.org/files/files/partnership/wg/.../December2014gapanalysis.pdf).
- Roll Back Malaria. (2012). *The Strategic framework for malaria communication at the Country level 2012-2017*. Retrieved from Geneva:  
<http://www.rollbackmalaria.org/files/files/globaladvocacy/docs/BCCstrategicFramework.pdf>
- Tesfazghi, K., Traore, A., Ranson, H., N'Fale, S., Hill, J., & Worrall, E. (2016). Challenges and opportunities associated with the introduction of next-generation long-lasting insecticidal nets for malaria control: a case study from Burkina Faso. *Implement Sci*, 11, 103. doi:10.1186/s13012-016-0469-4
- Tusting, L. S., Bottomley, C., Gibson, H., Kleinschmidt, I., Tatem, A. J., Lindsay, S. W., & Gething, P. W. (2017). Housing improvements and malaria risk in sub-Saharan Africa: a multi-country analysis of survey data. *PLoS medicine*, 14(2), e1002234
- United Nations, D. o. E. a. S. A., Population Division. (2017). *World Population Prospects: The 2017 Revision, Key findings & advance tables* Retrieved from  
[https://esa.un.org/unpd/wpp/Publications/Files/WPP2017\\_KeyFindings.pdf](https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_KeyFindings.pdf)

- World Health Organization. (2001). *Report of the Fifth WHOPES Working Group Meeting*. Retrieved from Geneva, Switzerland: [http://apps.who.int/iris/bitstream/10665/67046/1/WHO\\_CDS\\_WHOPES\\_2001.4.pdf](http://apps.who.int/iris/bitstream/10665/67046/1/WHO_CDS_WHOPES_2001.4.pdf)
- World Health Organization. (2004). *Report of the Seventh WHOPES Working Group Meeting: WHO/HQ, GENEVA 2–4 DECEMBER 2003*. Retrieved from Geneva, Switzerland: [http://apps.who.int/iris/bitstream/10665/68541/1/WHO\\_CDS\\_WHOPES\\_2004.8.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/68541/1/WHO_CDS_WHOPES_2004.8.pdf?ua=1)
- World Health Organization. (2009). *Report of the twelfth WHOPES Working Group Meeting*. Retrieved from Geneva, Switzerland: [http://apps.who.int/iris/bitstream/10665/69986/1/WHO\\_HTM\\_NTD\\_WHOPES\\_2009\\_1\\_eng.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/69986/1/WHO_HTM_NTD_WHOPES_2009_1_eng.pdf?ua=1)
- World Health Organization. (2012). *Report of the fifteenth WHOPES Working Group Meeting*. Retrieved from Geneva, Switzerland: [http://apps.who.int/iris/bitstream/10665/75304/1/9789241504089\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/75304/1/9789241504089_eng.pdf)
- World Health Organization. (2014). *Second Meeting of the Vector Control Advisory Group*. Retrieved from Geneva, Switzerland: [http://apps.who.int/iris/bitstream/10665/137318/1/9789241508025\\_eng.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/137318/1/9789241508025_eng.pdf?ua=1)
- World Health Organization. (2015). *World Malaria Report 2015: Summary*. Retrieved from Geneva: <http://www.who.int/malaria/publications/world-malaria-report-2015/report/en/>
- World Health Organization. (2016). *World Malaria Report 2016: Summary*. Retrieved from Geneva: <http://apps.who.int/iris/bitstream/10665/254912/1/WHO-HTM-GMP-2017.4-eng.pdf?ua=1>
- World Health Organization. (2017). *A framework for malaria elimination*. Retrieved from Geneva: <http://apps.who.int/iris/bitstream/10665/254761/1/9789241511988-eng.pdf?ua=1>
- WHO (2017) The evaluation process for vector control products. Information Note. [apps.who.int/iris/bitstream/10665/255644/1/WHO-HTM-GMP-2017.13-eng.pdf?ua=1](http://apps.who.int/iris/bitstream/10665/255644/1/WHO-HTM-GMP-2017.13-eng.pdf?ua=1)
- World Health Organization Global Malaria Programme. (2007). *Insecticide-treated mosquito nets: A WHO Position Statement*. Retrieved from <http://www.ivcc.com/sites/ivcc.mrmdev.co.uk/files/content/itnspospaperfinal.pdf>

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- Angus Spiers, Director I2I initiative <http://innovationtoimpact.org/>

## Key websites

- Private Sector Malaria Prevention <https://www.privatesectormalaria.org/>
- Private Sector Malaria Prevention Brochure <https://www.privatesectormalaria.org/wp-content/uploads/2017/02/PSMP-Brochure-Interested-Party-.pdf>

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## About this report

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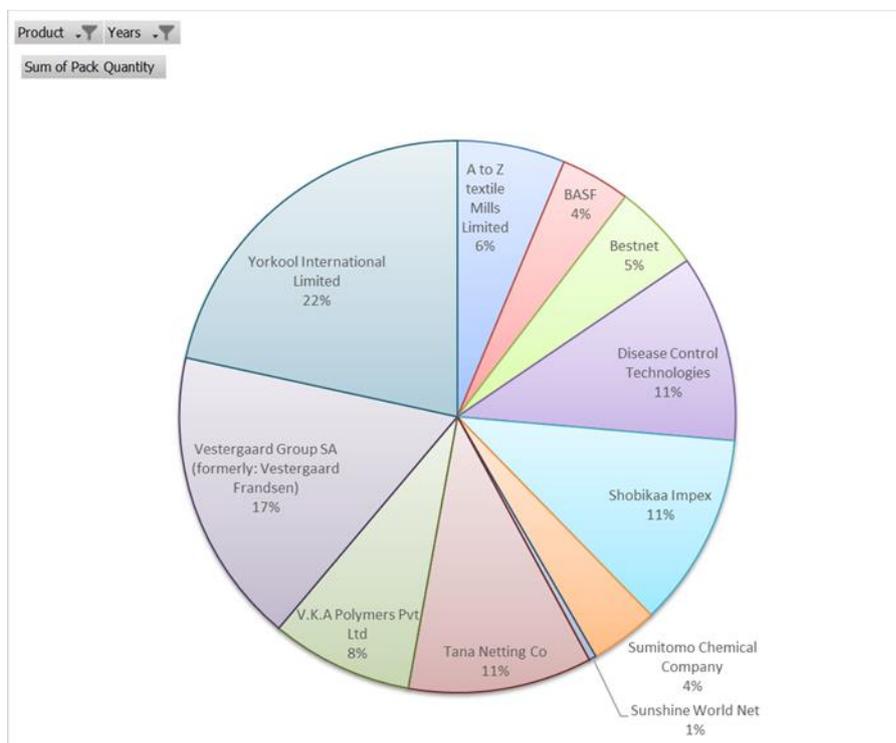
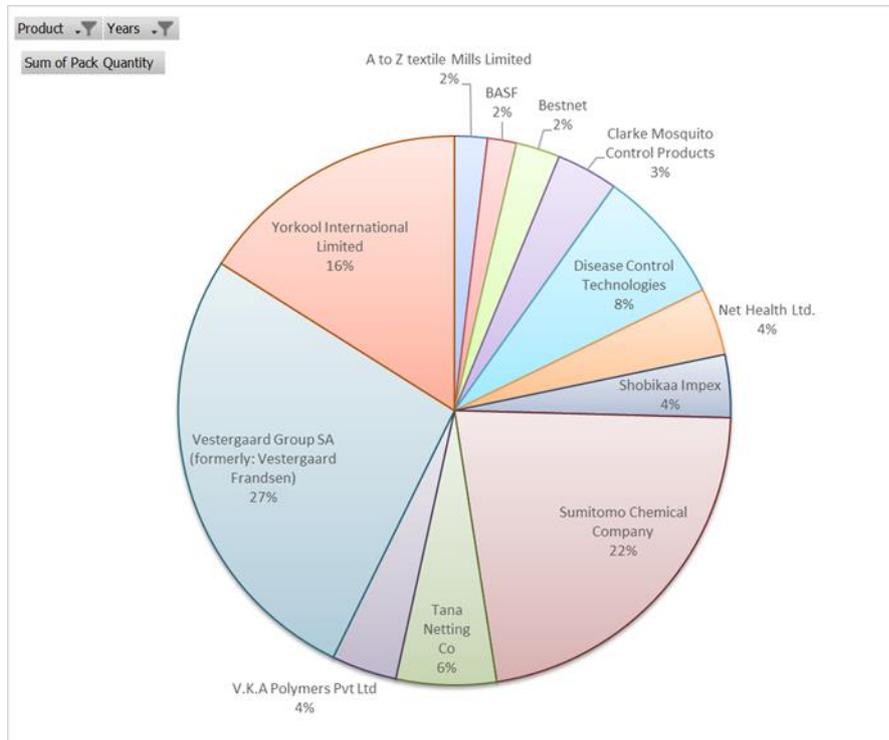
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## 8. Annexes

### Annex 1. Analysis of LLIN market share using data reported to the Global Fund Price Quantity Reporting database



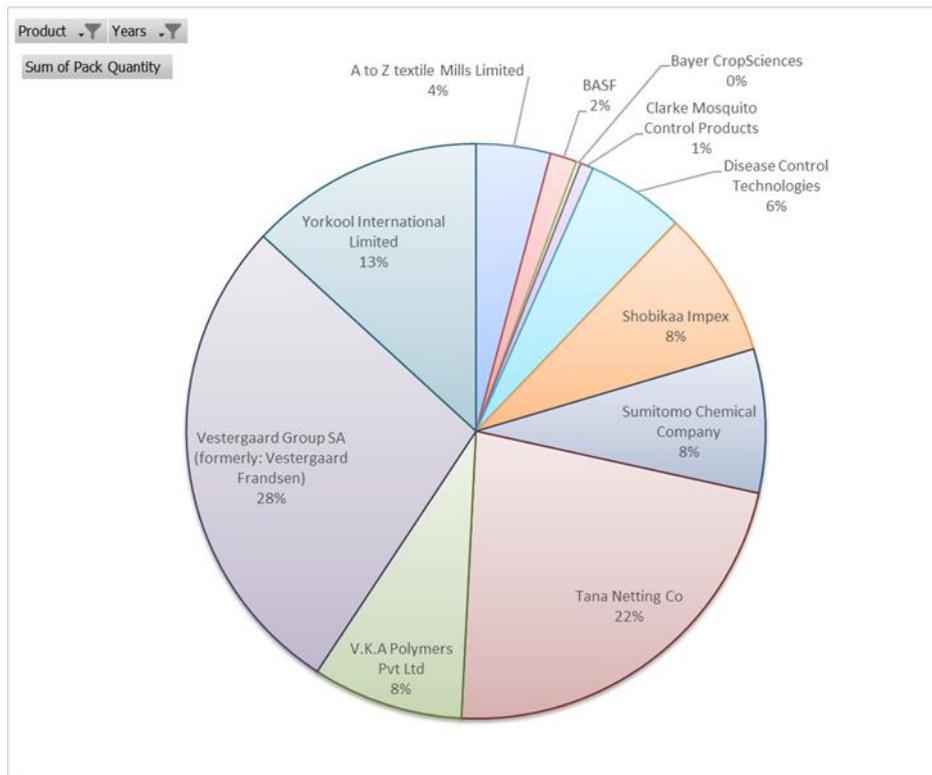
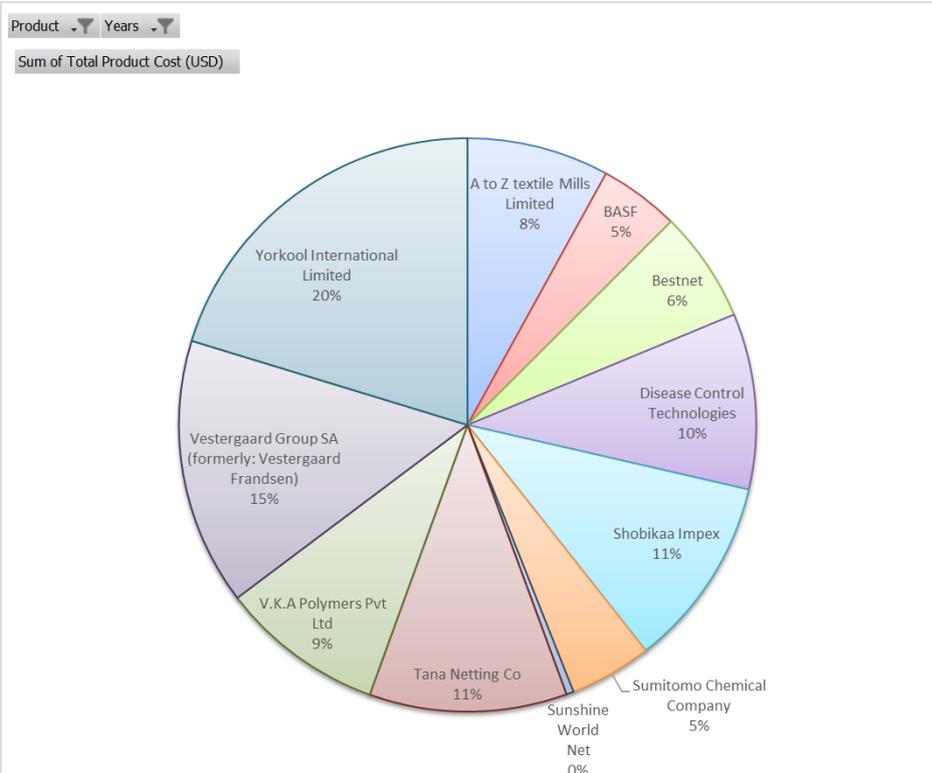
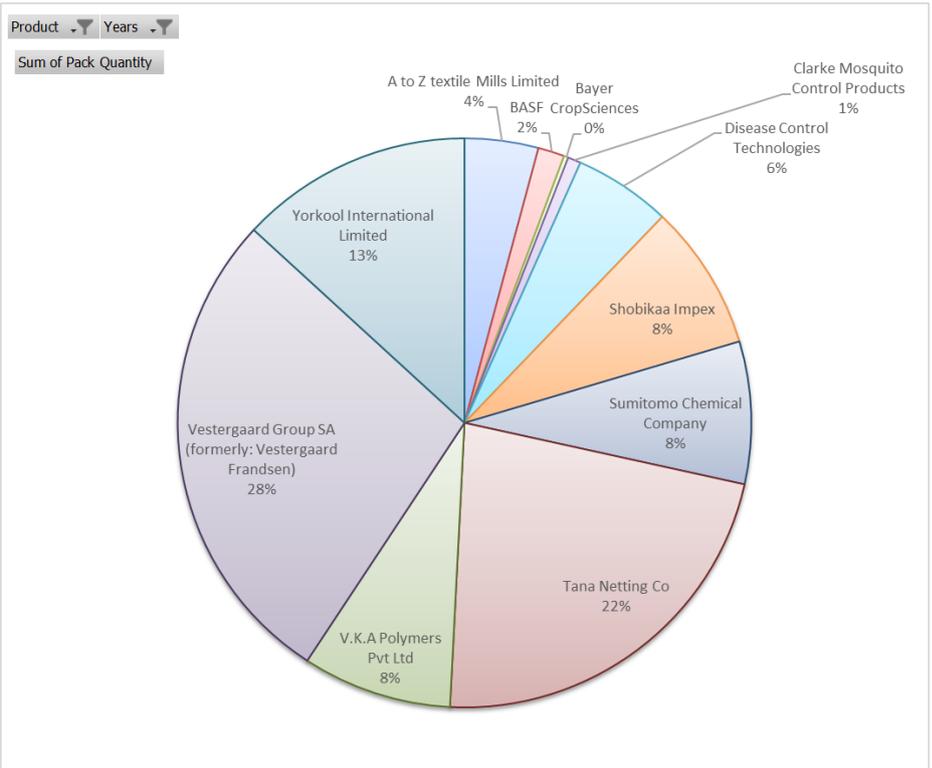


Figure 7 LLIN Market share by supplier, Quantity of nets 2013 (top), 2014 (middle) and 2015 (bottom) as reported to Global Fund Price Quantity Reporting database Transaction Summary..[<https://bip2-ext.theglobalfund.org/analytics/saw.dll?Dashboard>] Accessed 13/07/2017. Source of figure, Authors



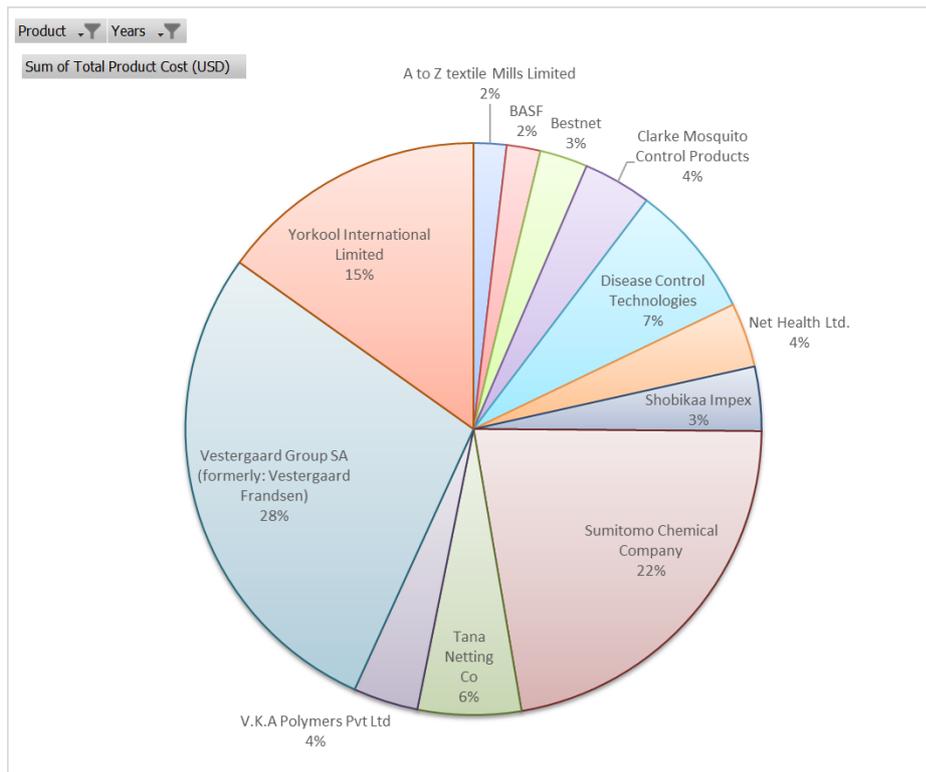


Figure 8 LLIN Market share by supplier and expenditure (US\$) of nets 2013 (top), 2014 (middle) and 2015 (bottom) as reported to Global Fund Price Quantity Reporting database Transaction Summary..[<https://bip2-ext.theglobalfund.org/analytics/saw.dll?Dashboard>] Accessed 13/07/2017. Source of figure, Authors

## Annex 2. Mind Map Constraints impeding growth of commercial sector on LLINs (source: Authors)

