KNOWLEDGE PARTNERSHIP PROGRAMME

Knowledge Partnership Programme

Final Narrative Report

South - South Technology Transfer: Low Carbon Building Technology

Development Alternatives- Technology and Action for Rural Advancement (TARA)

Submitted to

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Supported by:

Centre for Community Organization and Development, Lilongwe, Malawi
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The Government of UK's Department for International Development (DFID) is implementing a new model of cooperation support in India through the Knowledge Partnership Programme (KPP). This KPP is funded by the DFID and managed by a Consortium led by IPE Global Private Limited under its Knowledge Initiative.

About the Knowledge Partnership Programme

In the era of globalisation, India's strengths are its democracy, vigilant civil society, a growing economy and investment in development through policies, programmes and innovation. Considering the increased focus on South-South Cooperation development dialogue and India's experience in addressing development challenges and assisting development in various regions of the world, the Government of UK's Department for International Development (DFID) is implementing a new model of cooperation support in India through the Knowledge Partnership Programme (KPP). KPP is funded by DFID and managed by a Consortium led by IPE Global Private Limited under its Knowledge Initiative.

About Technology & Action for Rural Advancement

The Society for Technology & Action for Rural Advancement (TARA) is a social enterprise set up in the year 1985 at New Delhi, India. It is an "incubation engine" of the Development Alternatives Group which has been providing development solutions in India and elsewhere. TARA as an "enabler" is instrumental in the creation of livelihood support systems, training and capacity building for the rural poor and marginalized communities. TARA as an "aggregator" bundles support service packages, help large corporation explore new markets and also aggregate the output of local producer groups including micro, mini and small enterprises and connect these groups to market opportunities for BOP access and market development for ethical products and services. Governments, large Corporations and Civil Society networks benefit from TARA's expertise as a "manager" of large awareness creation, environmental action, community development and service delivery programmes in areas such as affordable housing, renewable energy, water management, sustainable agriculture, waste management and recycling.

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It would not have been possible for the team of Technology and Action for Rural Advancement (TARA), Development Alternatives Group; to undertake the South-South Technology Transfer initiative for introducing energy efficient and environment friendly building material technologies in Malawi without the active involvement and assistance of a number of individuals and organizations.

The team would, in particular, like to acknowledge the unflinching support given by all the staff and management of Centre for Community Organization and Development (CCODE), Lilongwe, Malawi; Eco Brick Limited, Selima and Enterprise Development Holdings, Lilongwe, Malawi. We would like to express our sincere thanks to Peter Schramm, Siku Nkhoma, Cynthia Phiri and Wonderful Hunga, Titus Malunga for supporting us beyond means in this initiative. Their constant aspiration of supporting Malawi to explore efficient construction through building material production inspired the team to achieve the same.

The team gratefully acknowledges the support from various Ministries of the Government of Malawi especially; National Construction Industry Council, Ministry of Land, Housing and Urban Development, Ministry of Natural Resources, Energy and Environment for their interest shown in the technology transfer initiative. Their interest to take out time and discuss possible means of cooperation with the implementation team shows their keen support for dissemination of cleaner building material production technologies in Malawi.

At the end and certainly not because they were the least important, TARA would like to highlight the crucial role played by building material manufacturers of Malawi in helping us understand the current situation, identify key issues, estimate the immense potential for modernization of the brick sector and chart out the way forward. The openness and alacrity with which they shared information and ideas was truly remarkable.

TARA would also like to acknowledge the support provided by the Indian High Commission, Malawi; British High Commission and DFID, Malawi and the German Embassy through German Cooperation, throughout the installation and commissioning of the VSBK technology. Presence of Honourable Ambassadors and High Commissioners at critical stages including the VSBK Inauguration boosted the morale of the team enabling them to perform to their best.

Finally, TARA gratefully acknowledges the support provided by Department of International Development, India and IPE Global, New Delhi for the technology transfer initiative undertaken. We do hope that this technology transfer pilot will encourage the introduction of new and sustainable building material technologies in Malawi to build up resilience to cope with environmental effects in future.

Technology and Action for Rural Advancement

Foreword

Given the strong South-South Cooperation development dialogue and India's long standing presence in assisting development in various regions of the world, DFID had identified a new model for increased cooperation support to India in the form of a Knowledge Partnership Programme. This Partnership Programme aims to step up collaboration around ideas, knowledge, evidence, accountability, technology and innovation, impacting the delivery of global public goods and services and leverage Indian experiences to reduce poverty in Least Developed Countries (LDCs). IPE Global is the technical and management partner for this programme.

Development Alternatives (DA) Group and TARA has been working for the last 3 decades in developing energy efficient and environment friendly technologies creating sustainable livelihoods. Technologies developed, tried and tested have been transferred to many countries in South Asia and Africa. Thus the Group has acquired capabilities of re-engineering home-grown technologies to suit the developmental needs for South-South coperation. In light of this, the Group is working a South-South technology transfer assignment for green building material technologies to Malawi.

The Centre for Community Organization and Development (CCODE) is a non-government organization which works in alliance with Malawi Homeless People's Federation to provide affordable housing to all. Over the last decade the construction of houses has been costly and thereby not affordable at all for the homeless. The quality of the buildings made through these building materials could have been improved. This has been mainly due to irregular shape and poor quality bricks, the use of which consumes high cement from large mortar joints and plastering. Over the last decade CCODE has been looking at low cost technologies to produce good and affordable quality building material so that the homeless can live in affordable, safer and better conditions.

The technology transfer initiative conducted by TARA in collaboration with CCODE, examined the feasibility of green building material production techniques and methods through a market survey. Emphasis was placed on Indian technologies like the Vertical Shaft Brick Kiln, Micro Concrete Roofing Tiles, RCC Door and Window Frames etc. which can be introduced and locally anchored through technical capacities in Malawi. These low carbon building technologies within the portfolio of TARA have potential to deal with the dual challenge of mitigating GHG emissions while catering to the housing demand through livelihood creation for poverty alleviation. Thus the programme focussed on building capacities of the local people on the pilot kiln site.

Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ANNEXURES

1. Market Assessment Report For Green Building Materials In Malawi
2. Inauguration Report
3. Technical Report on Commissioning
4. Training Report
5. Brochures Of Cleaner Production Technologies Suitable For Malawi
6. Set of Manuals
   a. VSBK Design Manual
   b. VSBK Construction Manual For Malawian Conditions
   c. Improved Green Brick Making Manual
   d. VSBK Operation Manual
   e. TARA BrickMek – SUPER User Manual
7. Awareness Workshop Report

Executive Summary

Republic of Malawi is a land locked country situated in Southern Africa. With a population of around 15 million, it has one of the highest rate of urbanization at 5.22%. This high rate of urbanization puts tremendous pressure on the entire building material sector. The main and only building material in Malawi is "burnt clay bricks". Use of alternate materials is sparse, limited only to subsidized construction activities. It has been estimated that with the current rate of urbanization, a minimum of 21,000 housing units are required to meet the urban housing demand. Thus Malawi will require around 1.7 billion units of burnt clay bricks annually. If the rural housing demand is also considered then the annual brick consumption will be much more.

Majority of the brick making in Malawi is small scale, unorganized activity. They are fired in traditional clamp kilns using fuelwood as fuel. 850,000 MT wood lost each year just for firing bricks can lead to complete deforestation in 30 years. The quality of bricks thus produced is far from desirous with uneven shape, size and compressive strength. With constraints in supply of material both the quality of material (brick) and the application (house) has degraded to an alarming extent resulting in poor quality and increasing construction costs.

Given the strong South-South Cooperation development dialogue and India's long standing presence in assisting development in various regions of the world, DFID has identified a new model for increased cooperation support to India. The Knowledge Partnership Programme aims to step up collaboration around ideas, knowledge, evidence, accountability, technology and innovation, impacting the delivery of global public goods and services and leverage Indian experiences to reduce poverty in LDCs. In light of this, the Development Alternatives Group proposes a South-South technology transfer assignment for green building material technologies to Malawi.

Keeping this in mind, the idea of technology transfer of the Vertical Shaft Brick Kiln (VSBK) for Malawi. The major objective in this initiative was to introduce an energy efficient and environment friendly technology to produce consistent quality bricks throughout the season. An assessment study illustrated that the Vertical Shaft Brick Kiln technology became the obvious choice especially looking at the scale of production and the fuel type in Malawi. The basic criteria's used to select technologies were based on production capacity, fuel type, product quality, investment capacity and ability to tap the carbon market.

The assignment leveraged the Indian experience in the brick sector to transfer technology effectively to Malawi. This technology demonstration and transfer initiative has major potential outcomes in augmenting the supply of green, affordable building materials while simultaneously adopting livelihood approaches to poverty reduction in an LDC like Malawi. In order to create a critical mass and ensure that the technology transfer is effective and taken up locally, a green building centre was commissioned in Lilongwe (based on demand seen during the feasibility study).

New approaches to operational practices require a paradigm shift from the conventional practices and the engrained mentality amongst entrepreneurs resisting to process innovations and new technology. Thus extensive awareness; intensive training and long term technology

support for entrepreneurs and operators to adopt improved technology options need to be an essential part of this transformation.

The environmental impacts of this initiative were the entry point. The change of fuel from wood to coal has direct impacts of reduced deforestation and thus better security from freak climate disasters like floods. The reduced energy consumption of the technology then allows the existing available energy to be diverted towards other productive uses, helping to enhance the quality of people's lives.

The technology transfer was well received by both the Government and private stakeholders. Queries from many interested entrepreneurs have been received from across the country. In addition buyers have expressed interest in purchasing the better quality bricks. The response from the Malawi Government has also been very positive. Mr Bright Musaka, Honourable Minister, Department of Land, housing and Urban Development, Government of Malawi, opened the awareness workshop by welcoming the transfer of such relevant technologies as the future of Malawi.

While the current environment is conducive to the introduction of new technologies and the need for such transfer is ripe, this is just the beginning. The technology transfer programme has received positive signs in terms of acceptance among the government and support from bi-lateral agencies. However, in order to achieve impact at scale it is important to tie up the technology transfer initiative with support particularly from the policy and finance end. Till the market is mature enough to innovate, policy needs to provide support to new technologies and developments. This area currently lies in vacuum, though the Government has expressed interest in taking up these issues, post this intervention.

"Alternate technologies like the VSBK are the future of the country. The Ministry will support all efforts to introduce such technologies in the country" ~ Mr Bright Musaka, Hon' Minister, Land& Housing, Government of Malawi

One of the chief challenges in this initiative was finding technically qualified people. Thus the technology transfer needs to be integrated with elements of capacity building and hand holding for the enterprises. Finance as an enabler cannot be ignored. It is important to seed and provide hand holding support to the first set of enterprises that will be created. There is a need to move beyond the first enterprise to create a critical mass of enterprises to demonstrate the potential for change both for the entrepreneur and the local economy.

An interesting spin off of the initiative has been the interest to move beyond the VSBK to other building materials for roofs, floors, frames, etc. There was also an expression of interest from neighbouring countries like Mozambique, Kenya, Ethiopia, Zambia and Tanzania. There is a need to explore these opportunities for future uptake.

Thus a longer term support program is imperative to achieve scale and impact that the technology transfer pilot envisions. With the backdrop of these assumptions, we can chart a course of widespread impact in the lives of the local Malawi home owners and entrepreneurs.

1. Introduction to Malawi

1.1 A Brief Profile

The Republic of Malawi is a land locked country situated in Southern Africa. It is bordered by Zambia, Mozambique and Tanzania. Measuring 48,000 square miles, it is a relatively small and densely populated country with limited mineral resources. One of the unique geographical treasures of Malawi is Lake Malawi, the 3rd largest fresh water lake in Africa. Part of the Great African Rift Valley, Lake Malawi is around 587 km and 84 km at its longest and widest point (Figure 1).

FIGURE 1: MAP OF MALAWI

With a population of over 15 million and an average annual per capita income of USD 268 (at current USD rates), Malawi is among the poorest countries in the world (World Bank, 2012). The economy is predominately agricultural and is dependent on substantial international assistance. In 2012, Malawi received official development assistance and official aid to the tune of USD 1.174 billion (current US$, World Bank, 2012). The Human Development Index, 2013 is 0.418, ranking Malawi at 170 out of 187 countries. 66.7% of the population live in multidimensional poverty (MPI 'head count', 2010) while an additional 23.4% were vulnerable to multiple deprivations, leading to an MPI value of 0.334. Life expectancy of 54.8 years with an average of 4.2 years of schooling put Malawi below the average for both Sub-Saharan Africa and other Low HDI countries. While Malawi has shown signs of development, this development has been very unequal. HDI when adjusted for inequality falls to 0.287 and the 2004 Gini coefficient is just 39.0. In addition Malawi has a Gender Inequality Index (GII) value of 0.573, ranking it 124 out of 148 countries reflecting gender-based inequalities in three dimensions – reproductive health, empowerment, and economic activity.

As of 2014, Malawi ranked 128 out of 178 countries on the Environmental Performance Index with a score of 40.06. In 2010, it had a total emission of 1,239 ktonnes CO_2 emissions with a per capita figure of 0.1 metric tons CO_2 emissions (World Bank, 2012). Malawi is one of the countries with the smallest Ecological Footprints, under 0.5 global hectares (1¼ acres) which is generally too small to meet basic requirements for food, shelter, infrastructure and sanitation (Global Footprint Network, 2009).

21,000 housing units required annually to meet the urban housing needs over the next 10 years.

To improve the situation of Malawi, it has been seen that the Government of Malawi is

planning to open up the infrastructure sector in the next decades and create favourable investment opportunities. This is expected to create a large demand on the building and allied materials. Moreover increasing urbanization will place a high demand on housing and related infrastructure. Thus there will be rapid increasing demand of building materials and technologies creating high interest for investment and profitable business in urban areas.

1.2 Housing & Building Material

Malawi's annual rate of urbanization is one of the highest in the world at 5.22% per annum (UNHabitat, 2010). This high rate of urbanization is putting pressure on the housing supply with deterioration in quality. Population growth patterns of Malawi's major urban centres indicate there will be 203,600 additional households by 2020 that, with an additional 25 per cent for the secondary urban centres, leads to a total demand for new dwellings of 254,500 by 2020. The Malawi Urban Housing Sector Profile 2010 reveals that 21,000 housing units are required annually to meet the urban housing needs over the next 10 years.

850,000 MT wood lost each year just for firing bricks can lead to complete deforestation in 30 years.

The main building material that is used in Malawi in both rural and urban settings for all building types is burnt bricks. In the last two decades there has been a significant shift from mud walls (46.6% to 19.9%) mostly to bricks. Not only in urban areas, also the percentage of dwelling units with burnt bricks has significantly increased in the rural areas from about 10% to almost 40% in this duration. In some cases alternate materials have been experimented but with limited success. Compared to burnt clay bricks, concrete and other cement based products only account for 0.6% of all walling materials (Figure 2).

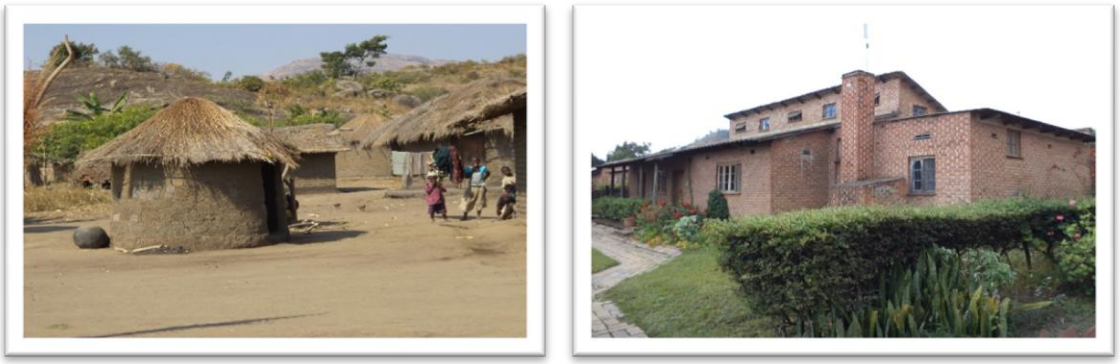

FIGURE 2: ADOBE HOUSE (LEFT); GOOD QUALITY HOUSE (RIGHT)

A low cost house will require an estimated 20,000 burnt bricks while a high income house will require an estimated 150,000 to 300,000 including bricks for fencing around the house. Thus on an average 85,000 burnt bricks will be required for the construction a single house. Therefore to meet the demand of 21,000 housing units needed each year, a minimum of 1.7 billion burnt bricks are required every year. This is just the bare minimum of the housing sector in urban areas only. If the requirement of rural areas including infrastructure requirements of public investment is calculated then the estimate of 1.7 billion per year will increase manifold.

In Malawi bricks are produced almost solely in traditional clamps fuelled with fire wood. Typically a clamp consumes around 20 Tonnes of wood to fire 40,000 bricks (Figure 3). This puts enormous pressure on the remaining forests in Malawi which are already under high pressure

from domestic demand. Given the pressure on forests and firewood, there is a keen interest of the government in the building materials sector, especially alternatives to traditional methods. Over the last few years, they are contemplating a ban on use of firewood for brick kiln firing and promoting concrete blocks. With no control on raw materials and process the product is extremely poor compared to the standards in other countries.

FIGURE 3: LARGE SCALE DEFORESTATION TO FIRE BRICKS (LEFT); WOOD FIRED CLAMP (RIGHT)

1.3 Drivers of Change

In the last few years, Malawi has seen an improvement in its development and poverty indices. As the country moves towards growth and development, people will have disposable incomes and will invest in essentials like housing. This is already evident from the housing demand and is slated to accelerate only. Building materials are estimated to contribute to about 60% of the cost of housing as well as the major chunk of the emissions from the sector. Bricks occupy a large share of this. This puts tremendous pressure on the entire building material sector. With constraints in supply of material and demand far outstripping supply, both the quality of material and the application (house) has degraded to an alarming extent. This has resulted in poor quality and increasing construction costs (Figure 4).

The prime driver for change is the rising concern on resource scarcity voiced by both the Malawian Government and the building material industry. As wood is the prime source of energy (both domestic and for brick firing), there is immense pressure of deforestation on the fast depleting forests. Current brick production will required around 850,000 MT of wood each and every year. At this rate of wood use, entire Malawi will be deforested within 25-30 years only from brick activity.

Poor brick quality and increasing deforestation prompt the search for alternatives

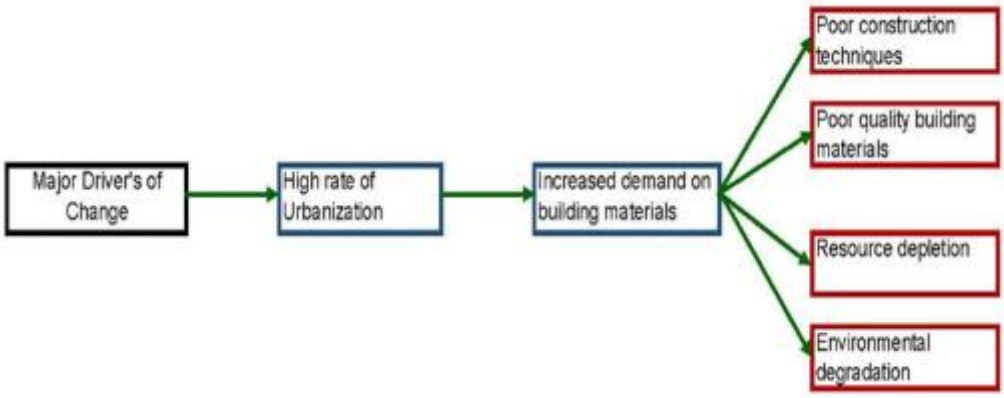

FIGURE 4: DRIVERS OF CHANGE

The poor quality of bricks is reflected in the lack of strength and consistency in shape, size and colour (Figure 5). Poor brick quality drastically impacts the quality of construction and the standard of living. The poor quality leads to use of excessive mortar. One of the largest contributors to the cost of construction is the cost of cement from these high mortar joints. These costs can be reduced for example in walls through standardized and good quality bricks from better construction and reduced use of cement mortar, Estimates peg reductions at about 25-30% from current conventional costs. Construction with traditional bricks is approximately 70% more than similar construction with good quality bricks. Thus use of quality bricks can drastically bring down the cost of construction of a low cost housing.

Poor quality housing coupled with the increasing deforestation in the country, has prompted the Government of Malawi to take notice of the situation and explore alternatives. Introduction of clean production technologies for quality bricks will reduce both the cost of housing as well as reduce the carbon intensity of the sector. Thus investing in technologies for production of clear and better quality building material is imperative to enable the sector to grow in a sustainable manner. During the course of the assessment, several meetings were conducted in Lilongwe, Malawi. The Department of Energy Affairs, Department of Environment Affairs, and National Construction Industry Council etc. have expressed a keen interest in promotion of such building materials like bricks and tiles from India.

FIGURE 5: AVERAGE BRICKS IN MALAWI

2. Overview

The initiative aimed to leverage the Indian experience in the brick sector to transfer technology effectively to Malawi. This technology demonstration and transfer initiative envisioned major outcomes in augmenting the supply of green, affordable building materials while simultaneously adopting livelihood approaches to poverty reduction in an LDC like Malawi. It would also lay the path for facilitating cleaner and greener development.

New approaches to operational practices require a paradigm shift from the engrained mentality amongst entrepreneurs resisting process innovations and new technology. This transformation requires extensive awareness; widespread demonstrations; intensive training and long term technology support for entrepreneurs and operators to adopt improved technology options. In order to create a critical mass and ensure that the technology transfer is effective and taken up locally, a **Green Building Centre** (GBC) was planned in Lilongwe. A further dissemination is however required to enable the technologies introduced to have large scale impacts on suitable development indicators of environment, economics and social well-being.

2.1 Objectives and Outcomes

The overall objective of the initiative was to introduce new technologies for building material production that will deal with the dual challenge of proving quality housing to communities while mitigating environmental damage caused.

This was done by achieving a three-fold objective of

- Transfer and adaptation of building material technological innovations viz. TARA VSBK;
- Awareness creation among the local stakeholders to adopt and promote new building technologies; and,
- Anchoring of technology in local context to ensure sustainability.

2.2 Approach

Successful technology transfer programmes have known to include both the hardware and software skills e.g. equipments, tools and accessories, the entire production system know-how, material testing, analysis and quality control capability. Besides the technical aspects there are other areas that need intervention and influence so that sustainability of the initiatives launched are demonstrated.

Thus, a holistic approach was applied that considers the technological, environmental, economic, social and institutional aspects towards a successful technology transfer programme. Being set up primarily as an environmental and skill development programme the entry points were the environmental and economic thematic areas. During implementation, interactions with various Government Departments were initiated for setting up the atmosphere for favourable policies towards uptake of greener technologies.

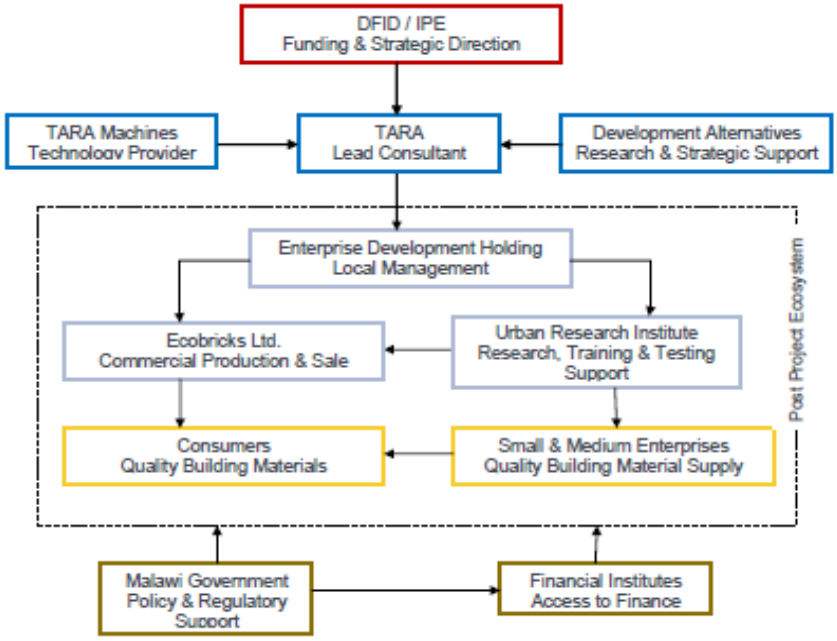

FIGURE 6: ORGANIZATIONAL STRUCTURE OF THE TEAM & PARTNERS

The introduction of the technologies was anchored in the Malawi local context to create ownership and assess development potential. In this context, the initiative identified organizations in Malawi for knowhow transfer, to work together in partnership mode (Figure 6, Table 1).

TABLE 1: ROLES OF STAKEHOLDERS

Partner	Role	Responsibility
DFID / IPE Global	Funding Agency	Financial and Technical Support
TARA	Lead Consultant	Overall Management and facilitation, commissioning of GBC, Training & capacity building
Development Alternatives (DA)	Research & Strategic Support	Feasibility study, regular reporting, knowledge product development , energy assessments
Enterprise Development Holding (EDH)	Local Management support	Deployment of dedicated technical personnel. Provision of all infrastructure support to TARA at Malawi during missions.
Ecobricks Ltd.	Green Building Centre – commercial production & sale	Investment in land, building, office spaces, work sheds, at site ; Investment in procurement, installation of VSBK, equipments and machineries
Urban Research Institute	Research, Training & Testing Support	Investment in research and testing equipments; procurement of equipments and machineries
Government of Malawi	Policy & Regulatory Bank	Preferential policy environment for energy efficient technology, standards and specifications for quality material
Financial Institutions	Access to Finance	Ensuring easy access to small and medium enterprises, consumers, simplified guidelines
Small & Medium Enterprises	Quality Building Material Supply	Establishing enterprises to ensure market uptake of technology and products
Consumers	Quality Building Material Use	Home owners, developers, contractors to build and construct structures

The investment made included:

- Hardware investment by Malawian stakeholders i.e. private companies who will be adopting the technologies (e.g. construction of the VSBK pilot, building centre, land and machineries, building material equipment, cost of VSBK, research and testing equipments)
- Software support (training and capacity building, early trouble shooting) to enable local stakeholders
- Building and making use of local capacities (anchoring of expertise capacities in Malawi)
- Influencing policy in Malawi for creating an enabling atmosphere for enterprise development and technology uptake
- Generation of knowledge products and manual for anchoring technology in Malawi

3. Methodology & Outputs

A five phased methodology was followed to achieve the objectives of this initiative (Figure 7).

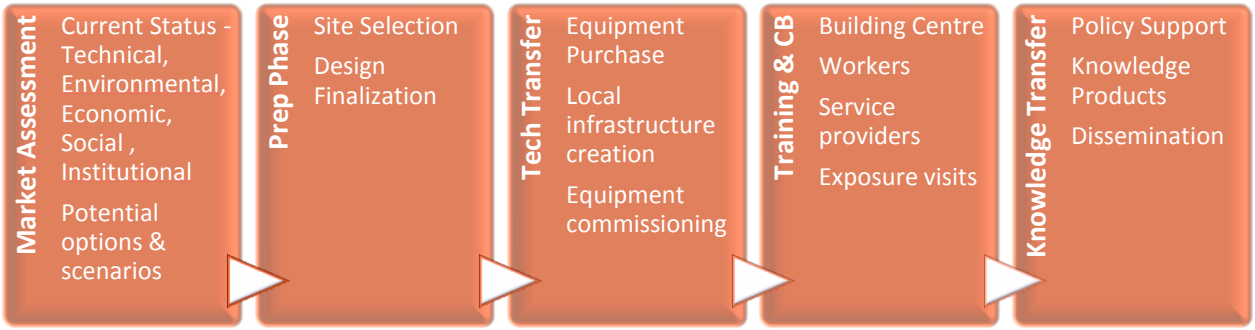

FIGURE 7: METHODOLOGY FLOW CHART

3.1 Market Assessment

An assessment study was undertaken to evaluate the current status of the market and the feasibility of introducing cleaner production technologies in the construction sector in Malawi, especially for the brick sector. With the need to adopt cleaner brick production technologies evident in the country, the team explored the market potential of the Vertical Shaft Brick Kiln (VSBK). The basic criteria's used to select the technology were based on production capacity, fuel type, product quality, investment capacity and ability to tap the carbon market.

Design and construction of the VSBK has to be under expert supervision during initial years.

The assessment showed that from the technical viewpoint there were no issues for designing and construction of a VSBK in Malawi. Basic competency exists which needs to be developed and upgraded extensively to suit the quality required for construction of a VSBK. However during the initial couple of years, the design and construction of the VSBK has to be under expert supervision. Preliminary economic and financial analysis of the VSBK technology showed that it could be an alternate technology to replace the clamp kilns and stop use of fuelwood (Figure 8). VSBK is expected to have its own niche market amongst all the brick production capacities thereby promoting the growth of SME sector in Malawi.

FIGURE 8: TRADITIONAL BRICKS IN MALAWI

Thus the study illustrated that all pre-requisites to transfer this technology to Malawi exists and the initiative would have the support of most institutions in the Malawian housing sector. Table 2 illustrates how the VSBK makes economic sense to be introduced to in Malawi.

TABLE 2: RECOMMENDED SCALE OF OPERATION

Parameters	VSBK 1 - shaft	VSBK 2 - shaft
Daily output (bricks)	4,500	9,000
Days of operation	300	300
Annual capacity (bricks)	1,350,000	2,700,000
Capacity utilization	90 %	90 %
Annual production (bricks)	1,215,000	2,430,000
Investment	8 million	15 million
Selling Price	15 MK / Brick	15 MK/ brick
ROR	~3 years	~2 years

In addition it highlighted the potential for other low carbon building technologies like Micro Concrete Roofing Tiles, RCC Door and Window Frames etc. from within the portfolio of TARA to deal with the dual challenge of mitigating GHG emissions while catering to the housing demand through livelihood creation for poverty alleviation. A summary of the other alternative materials is given in Table 3.

TABLE 3: SUMMARY OF ATLERNATIVES

Sectors	Building materials presently used	Alternative proposed	Benefits
Roof	• Thatched materials • Metal sheet roof with false ceiling • Concrete flat roof • Tiled roof with false ceiling • Concrete sloping roof with decorative tiles	• Micro concrete roofs with and without false ceilings • Flat roof with filler materials • Planks and joists • Funicular shells	• Low cost, versatile, load bearing, easy to produce • Low construction time • Low material consumption • Durable and aesthetically pleasing
Wall	• Adobe bricks • Burnt clay bricks fired in clamps • Stabilized soil blocks • Concrete Blocks	• Vertical Shaft Brick Kiln for burnt bricks • Mechanized Concrete Blocks	• Better quality of product • Less use of mortar • Durable and aesthetically pleasing
Frames	• Wood • Steel	• Reinforced Cement Concrete	• Durable as compared to wood • Less construction time but fits into existing practices • Less cost, easy to produce, versatile
Floor	• Skreet Concrete • Tiles • Pavers for roads	• Semi-mechanized medium and heavy duty pavers	• Low cost • Versatile and easy to produce • Durable and aesthetically pleasing

More detailed information on the assessment study can be accessed from the Market Assessment Report (Annexure 1).

3.2 Preparatory Phase

This short but essential phase laid the ground for the successful transfer of the technologies. The objective was to ensure that everything is ready before the technology and equipment are transferred on the site. Two sets of activities were undertaken.

- Selection of site, layout and design
- Process engineering of raw materials

FIGURE 9: THE SITE

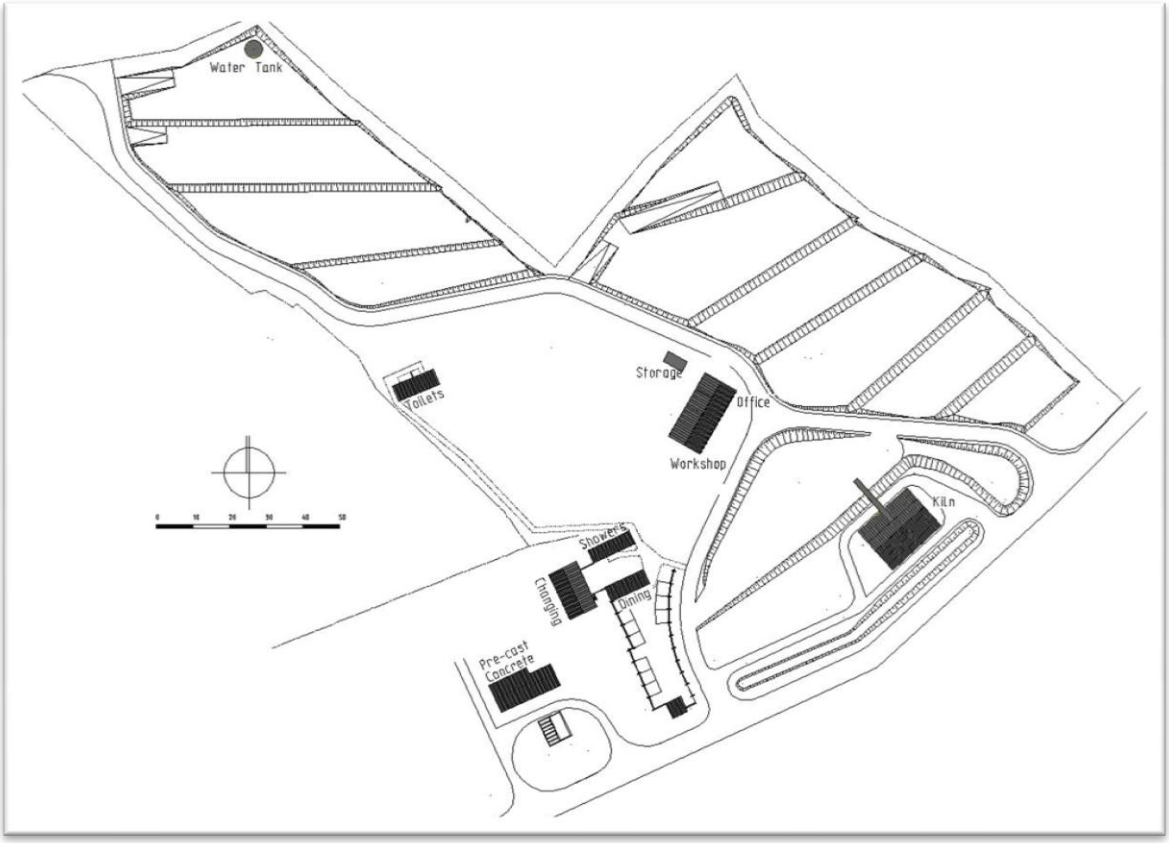

FIGURE 10: THE SITE PLAN

The site for the green building centre was selected (Figure 9). This was done in the vicinity of the VSBK pilot structure. Once the land and site were frozen, a layout and design exercise was undertaken (Figure 10). The objective of this was to ascertain positions of various equipments to ensure smooth functioning of the centre. Provisions were also made to account for the needs of the staff employed at the centre.

A parallel set of activities focused more on the raw materials for process engineering. An exercise in raw material selection was undertaken to identify appropriate materials for the brick making. This also involved testing of raw materials like the soil and fuel used to determine the mix composition.

This phase also served as an initiation for the partners and end users, as they were beginning to become more involved in the initiative.

3.3 Technology Transfer

The crux of the initiative rests in this critical step. It involved the installation and commissioning of the equipment, creation of local infrastructure and production at the Building Centre. Close co-ordination between all the technology providers, local support systems (potential and existing) and the entrepreneur was critical here.

Based on the market assessment, the local partners decided on the technologies to be transferred. The VSBK reflected favourably in this choice. Equipment for efficient green brick making was part of the technology transfer package. Quotations were invited from local and overseas suppliers including Kenya, South Africa, China, Germany and India. However equipments and machineries from TARA Machines and Tech Services Pvt. Ltd., India was selected due to lowest price and certified quality.

FIGURE 11: THE VERTICAL SHAFT BRICK KILN

Simultaneously local infrastructure was developed to house and install these technologies. This was done in accordance with the layout and design finalized in the Preparatory phase. The equipment was then commissioned on site for pilot production (Figure 11). The equipment was used to produce green building material, green bricks in this case. During the course of this training, a stock of over 100,000 bricks has been created, that would then be fired in the VSBK. These technologies improve the quality of green bricks. The green bricks thus moulded have been tested and have proved to be of better quality and uniform size unlike the traditional bricks in Malawi.

These were then fired in the constructed VSBK. Various types of internal fuel tested for the firing. This included oil cake waste, boiler ash waste, tobacco dust waste and coal mine waste.

All were found suitable for brick making. Currently they are using 5% tobacco dust to make the green bricks.

Training components were inbuilt into this process.

Output:

- Inauguration Report (Annexure 2)
- Technical Report on Commissioning (Annexure 3)

3.4 Training & Capacity Building

This is the fourth step in the technology transfer. The training process moved together with the construction and commission as described in the previous step. Training was provided at different levels for masons, kiln workers and entrepreneurs.

Mason Trainings

The construction training programme was held in Lilongwe **from** June 2014 to July 2014 on the kiln site. Several local masons were involved in the construction of VSBK at Mthyoka, Lilongwe. An initial assessment to understand the working ability to take over the task of critical construction gave encouraging results. The selected masons were then further trained in VSBK construction.

The objectives of the training programme were to train the masons on constructing the VSBK. The major outputs for trainees were to understand how to read plans and construct the VSBK and get hands on experience in doing so. The approach adopted for the training was participant centered, with an emphasis on practical experiential learning by doing. Nine masons were trained in this duration.

Kiln Workers

Workers were trained in various aspects of operating and maintaining the VSBK (Figure 12). This included

- Installation and operation of equipment
- Green Brick Making
- Firing & Commissioning the kiln
- Regular operation & maintenance

FIGURE 12: TRAINED WORKERS ON SITE

Two new technologies were introduced to improve the traditional slop moulding process. One is a manual sand moulding process. 8 workers have been trained in this. A very quick adaptation to sand moulding was observed. Another 17 workers were trained in the semi mechanized process of using the soft mud moulding process. These were unskilled workers who were trained and have been then absorbed in EcoBricks Ltd. thus providing them with

jobs. While the 15 day training, gave them basic skills, there is a need to continue to monitor quality. Of these 25 people trained, seven were women.

12 persons were trained in the VSBK firing operation. These 12 persons will operate in 3 shifts of four persons. These four persons are three firemen and one fire master. The above will be supervised by a team of two technically qualified supervisors. Two of the fire masters underwent a training prior to the commissioning, on site in India. Their skills were strengthened during the installation of this equipment in addition to other operators in Malawi (Figure 13).

A supervisor was hired to co-ordinate work in Malawi by EcoBricks Ltd. The technical knowledge transfer was done to him, so there is local anchoring of the knowledge. The technical training to him included

- Quality control and testing
- Continued operation of kiln and monitoring of results
- Troubleshooting of kiln operation and quality adjustments

He will now play the role of a master trainer, training others who join the kiln.

Output :

- Training Report (Annexure 4)

FIGURE 13 : HIERARCHY OF TRAINEES

3.5 Knowledge Transfer

The assignment operated in an open and transparent setting and high preparedness for learning. At local level all activities were implemented in a coordinated way together with the stakeholders concerned. In particular, an open information strategy was followed with concerned government institutions, the building material production community as well as with relevant NGOs.

Existing knowledge was built upon, and enhanced through capacity building as far as required. The models (products and processes e.g. technologies) developed by the Programme was documented and made accessible in a user-friendly way and tailored for the stakeholders concerned. Documentation on different aspects of the technology including details of equipment and accessories, raw material selection, production process, quality control and application was distributed among enthusiastic entrepreneurs and investors. This last step moved concurrently through the course of the entire assignment.

Another activity conducted was facilitating awareness and demonstration visits of various stakeholders. This included exposure visits to the Green Building Centre to generate interest among new entrepreneurs and other stakeholders regarding the technical features of the technologies, financial benefits associated with local production and enterprise generation capabilities. It was done both on demand as well as through specific workshops organised for this.

The Vertical Shaft Brick Kiln (VSBK) in Salima, Malawi was commissioned on 26th January 2015. An inaugural function was held to commemorate the firing. The kiln was fired by the dignitaries from the different governments and senior functionaries of the local partners. The event was graced by Mr. Martin Scale, Deputy High Commissioner - British High Commission Malawi, Mr. Vanlalhuma, Indian High Commissioner to Malawi, Dr. Peter Woeste, Honorable German

Ambassador to Malawi and the Chief Housing Officer, Government of Malawi in addition to other key representatives from the India, British and German embassies. Representatives from Technology and Action for Rural Advancement (TARA), Deutsche Gesellschaft für Internationale (GIZ), EcoBricks Ltd, Housing Company, Enterprise Development Holding (EDH) and Centre for Community Organisation and Development (CCODE) were present. Around 120 guests participated in the workshop with representatives of users, industries, waste generators, policy makers etc.

An awareness workshop on cleaner brick technologies was held on 27th February 2015 in Lilongwe, Malawi (Figure 14). The objective of the workshop was to introduce the Vertical Shaft Brick Kiln (VSBK) to interested stakeholders as well as disseminate the results of the pilot kiln that was set up. The highlight of the workshop was the presence of Mr Bright Musaka S.C., Minister of Land, Housing & Urban Development and his offer for unstinting support in promoting the widespread adoption of alternate technologies like the VSBK.

The workshop was attended by over 60 interested entrepreneurs and developers. There was healthy participation from the government of Malawi. Representatives from the Technical, Entrepreneurial and Vocational Education and Training Authority (TEVETA), National Construction Industry Council (NCIC), Ministry of Land, Housing & Urban Development attended the workshop.

FIGURE 14: AWARENESS WORKSHOP IN MALAWI

Output :

- Brochures of Cleaner Production Technologies for Malawi (Annexure 5)
- Set of 5 Manuals (Annexure 6)
  - VSBK Design Manual
  - VSBK Construction Manual
  - VSBK Operation Manual
  - Green Brick Making Manual
  - TARA BrickMek-SUPER User Manual
- Awareness Workshop Report (Annexure 7)

3.6 Outputs and Deliverables

The key deliverables under the initiative included

- Market Assessment Report for green building material in Malawi
- Technology transfer and demonstration of a portfolio of green building materials Report
- Brochures of Cleaner Production Technologies suitable for Malawi
- VSBK Manuals
  - VSBK Design Manual
  - VSBK Construction Manual for Malawian conditions
  - VSBK operation and trouble-shooting manual
  - Improved green brick making manual
  - TARA BrickMek User Manual
- Training Report
- Inauguration Workshop Report
- Awareness Workshop Report
- Final report with recommendations to ensure accelerated adoption and scale up of the technology portfolio

4. Challenges Faced & Coping Strategies

As in any project, this one too was faced with teething troubles and challenges while implementation. These delays inadvertently delayed the completion of the initiative by more than 3 months beyond the envisioned time period of 9 months. Although these delays were agonizing, however it is important to understand and appreciate the socio-cultural aspects of the country as they closely govern the progress and success of any initiatives.

4.1. Absence of Local Technical Skill

Overall progress was a little slow due to the non-availability of trained / skilled technical workforce. While we have been building capacities of the local labour force through the duration of the initiative, the status is still far from ideal. Getting them up to the desired skill level is an intensive long term activity and takes time. This is all the more so, since the initiative is making a paradigm shift in the way bricks are been made in Malawi. Our technical team closely monitored the progress and helped accelerate the process to the extent possible.

With the prevalent low technical skill levels and low levels of exposure to technology, bringing about a change of mindset among the local people was also a major challenge faced by the team. While at the government level, there is more acceptance of change, at the worker/ unit level, the team had to engage extensively to build up their confidence in the technology. This required more time from Indian experts at Malawi for hand holding at each and every stage of the construction.

4.2. Absence of locally available materials

As defined earlier Malawi is one of the least developed countries. With very low industrial initiatives, the basic support infrastructure for any micro to small scale is practically non-existent. Thus every basic equipment, spare parts and raw materials like cement have to be imported. With no control on external import market, the team often faced the challenge of regular and timely supply of materials. In some cases cement was out of stock in the country for 2 months. Diesel was in short supply which restricted movement of staff to site. Import of machineries and equipments was also delayed due to issues in release of foreign exchange and held up at the port of shipment. This resulted in equipment to be imported from India.

4.3. Delays in Procurement

Besides the local conditions, another challenge arose due to the fact that the initiative depended on external factors to ensure infrastructure was in place. Based on decisions taken post the results of the assessment study, equipment for the kiln was shipped from India to Malawi. There was a hold up at the Durban port for a month for reasons unknown. This retarded the pace of the commissioning.

On the other hand, the site needed an electricity connection for equipments to be commissioned. While the application for the electricity connection had been made at the beginning of May, it was only towards the end, that any confirmation from the ESCOM was received. In spite of persistent follow up, the electricity connection has not been secured till date. The plant is currently running on diesel. This has a very negative impact on the profitability of the unit. Interventions through the Honourable Minister, Land, Housing and Urban Development, have been sought now to remediate this issue. Continuous follow up will continue on this issue.

5. Lessons Learnt

The knowledge and technology transfer initiative brought out some very interesting lessons that can help define South-South Development Cooperation. The aim of this cooperation is to take forward the collaboration n ideas, technology and innovation among the developing world. These elements form essential building blocks for such initiatives in the future as well.

5.1. Long Term Programme with a Focus on Capacity Building

The crux of a technology transfer initiative lies in the local anchoring of the technology. For optimum results, the technology needs to be transferred to a local institution – NGO, training agencies, building councils, etc. The capacity of the local institution to absorb this technology and knowledge is also very crucial. Also important is the capacity building of individuals who then become repositories of the transferred knowledge for further dissemination.

It must also be appreciated that building institutional and individual capacity is a time intensive long term initiative. While trainings and workshop help lay the ground, continuous hand holding and early trouble shooting is essential to bring up skills and capacities to the desired level.

5.2. South-South Development Cooperation

One of the aspects of success of the initiative is that the Cooperation is between two developing countries. India is uniquely placed, where it understands the socio-economic and cultural aspects peculiar to the developing world. At the same time, it has technologies and innovations that can delivery basic needs and services while alleviating poverty. This combination places India in a distinctive position to transfer technologies and ideas through the South-South Development Cooperation modes.

5.3. Integrating Intervention into Larger Context

The primary aim of the initiative was to introduce the VSBK, a technology that makes better quality bricks while arresting deforestation. However in order to ensure that the transferred technology is accepted it is important to firmly anchor it in a larger context. In this case, the context is housing. The bricks that are produced using the new technology are high quality bricks. These bricks will improve the quality of housing and simultaneously reduce costs. This is a benefit that is very tangible to entrepreneurs and users alike.

Placing the introduced technology in a relevant context allows for better mainstreaming with the stakeholders. It is thus imperative to thus move beyond just the technology and look at its application to enhance acceptance. It also helps in promoting large scale adoption beyond the pilot intervention.

5.4. Involvement of Women

The traditional brick making sector in Malawi is predominately occupied by men. Women have a negligible role to play. This is unlike the experience in India, where women play a key role especially in functions such as moulding. During the capacity building trainings conducted under this initiative, however women were trained in the use of the soft mud moulding machine. It was encouraging to see how well they picked up and have now become an integral part of the kiln. The livelihood creation aspect for women is an interesting and noteworthy fall out of the initiative.

6. Outcomes & Impacts

6.1. Technology Transfer

The most obvious and direct impact of the initiative was the successful transfer of the VSBK technology to Malawi. This technology has the potential to transform the housing sector in the country by creating supply of Improved and consistent quality bricks as well as extended brick production

Some of the technical highlights include:

- The introduction of VSBK with a Specific Energy Consumption of 0.8 MJ/kg has led to an energy reduction by 75%
- Vast improvement in green brick quality. The density improved from 1.46 to 1.72 gm/cc due to adoption of the moulding technologies.
- Use of alternate fuels (from fuel wood) like coal, there is further potential to explore a low CV and low volatile coal, and thus lower price
- Introduction of Internal fuel like tobacco dust in green bricks (5% by weight) for extremely reduced energy consumption
- Reduced breakage from the prevailing to 50% to less than 15%

The technology transfer was very well received by both the Government and private stakeholders. Queries from many interested entrepreneurs have been received from across the country. In addition there has been a lot of interest from buyers, to purchase the better quality bricks.

Technologies like this are the future of Malawi, there should be one in every constituency ~ Honourable Bright Musaka, Minister of Land, Housing & Urban Development

The response from the Malawi Government has also been very positive. Mr Bright Musaka, Honourable Minister, Department of Land, Housing and Urban Development, Government of Malawi, who presided over the awareness workshop welcomed the transfer of such relevant technologies as the future of Malawi. He highlighted the need for appropriate alternate technologies given the great need for quality housing in the country and the lack of options currently. This is particularly important in light of the recent debate led by the Prime Minister on the need to revamp government housing schemes.

6.2. Environment & Forests

The environmental impacts of this initiative were the entry point. The change of fuel from wood to coal has direct impacts of reduced deforestation and thus better security from disasters like floods. The recent floods further cemented the need to bring about change in the business as usual scenario. The reduced energy consumption of the technology then allows the existing available energy to be diverted towards other productive uses, helping to enhance the quality of people's lives.

The technology also allows for use of carbonaceous wastes as internal fuel. This includes waste from agriculture, coal mines, tobacco factories that are currently just dumped and unused.

The environmental highlights if the technology were to be adopted in the country are summarized below

- Saving of 850,000 tonnes of fuelwood annually
- Saving of 1,500,000 tonnes of CO_2 annually
- Use of more than 90,000 tonnes of industrial wastes

6.3. Gender & Social Aspects

The technology transfer with its built in capacity building has lead to the training of unskilled labour and to provide local jobs. Being a decentralized technology, such enhanced opportunities can be created in every constituency. In fact, this was the ambition expressed by the Minister of Land, Housing, Urban Development when he visited the kiln.

Women workers have been trained in green brick making

Infact he particularly appreciate the fact that women were an integral part of the trained cadre at the kiln. He encouraged the women to learn to make the prefect brick, using the machine and promised to be back to check on them and their progress.

The nature of work on the kiln, adopting principles of selective mechanisation encourages employment for women as well. As part of current pilot, 12 women were trained in green brick making both through hand moulding and through use of the Soft Mud Moulding machine. Improved skill levels also enhance their income opportunities.

Overall the introduction of this technology brings into the market, the option for home owners to purchase quality bricks. The uniform size of these bricks improves the quality of construction while reducing the cost of construction leading to a better quality of life.

6.4. Market & Investment

The private sector has expressed an interest in the introduction of the new technology. While they acknowledge environmental benefits, the prime benefit they see is the reduced cost of construction for quality structures. There have been enquires into the process of establishment of more such kilns. Also interest has been received from developers who are interested in purchasing bricks in large numbers from the kiln.

The initial response received has been quite overwhelming. Given the housing boom anticipated and the lack of quality products in the market, the potential for this technology is acknowledged to be very large. This can be quantified as

- Recurring income of USD 9 million worth of foreign exchange annually through carbon revenue
- Creation of more than 1,000 SME's
- Creation of more than 20,000 sustainable jobs

6.5. Spin Off Impacts

The engagement with both public and private stakeholders in Malawi revealed a very high interest for technology transfer of cleaner brick production technologies. The team uncovered potential for the adoption of other green building materials in addition to the VSBK. These include technologies for prefabricated roof panels and tiles, door and window frames, pavers, etc.

It has also resulted in an expression of interest from the neighbouring countries to undertake similar exercises to explore the potential of technology transfer. Some of the countries from where interest has been received include Mozambique, Kenya, Ethiopia, Zambia and Tanzania. It is worth to note here that the interest has come from the private sector in these areas. The drivers here also reflect an interest in a technology that provides an affordable quality product while causing minimal environment damage as a secondary cause.

7. Way Forward

The increasing housing demand exerts pressure in the current building materials market both formal and informal. The formal sector, being rather small in terms of the informal cannot currently meet the demands of the country. Thus the informal market assumes an important position in the housing market of Malawi, primarily due to its cost and convenience advantage. However it suffers on account of limited access to new and improved technologies promoting quality building products with selective mechanisation. The technology transfer initiative fills this gap.

Technology transfer initiatives need to be coupled with capacity, policy and financial support.

While the current environment is conducive to the introduction of new technologies and the need for such transfer is ripe, this is just the beginning. The technology transfer programme has received positive signs in terms of acceptance among the government and support from bi-lateral agencies. However, in order to achieve impact at scale it is important to tie up the technology transfer initiative with support particularly from the policy and finance end.

The capacities of the small and medium scale entrepreneur, ideally suited to fit this role are limited. The entrepreneurial ecosystem is not well developed. Technical skills and capacities are underdeveloped. One of the chief challenges in this initiative was finding technically qualified people. Thus the technology transfer needs to be integrated with elements of capacity building and hand holding for the enterprises. This skilled workforce is a key ingredient in promoting the technologies and achieving scale. Training cannot be adopted as a one-time initiative. This needs to be done at various levels ranging from establishing new entrepreneurs to workers at the enterprise as well as masons during construction. In order to fill existing gaps it is important to have a continued long term engagement so principles of technical management are ingrained locally.

Policy support in the form of codes and regulations for new materials is one of the first steps in mainstreaming these technologies. Policy research also needs to explore and understand how these materials and technologies can be incentivized for the users through fiscal and regulatory measures. Till the market is mature enough to innovate, policy needs to provide support to new technologies and developments. This area currently lies in vacuum, though the Government has expressed interest in taking up these issues, post this intervention.

Finance as an enabler cannot be ignored. While the technology transfer has been met with positivity, the impact of the initiative will be seen only when more and more entrepreneurs adopt the technology. The current financial landscape defies this movement. The lack of access of capital and the limited risk taking ability of locals is a deadly mix to retard the good progress a pilot technology transfer can make. Thus it is important to seed and provide hand holding support to the first set of enterprises that will be created. There is a need to move beyond the first enterprise to create a critical mass of enterprises to demonstrate the potential for change both for the entrepreneur and the local economy.

This pilot intervention has paved the way for South-South Development Cooperation, where in India can play the role of a technology provider. While a good beginning has been made, it is imperative to consolidate the work done and explore opportunities for further dissemination. Consolidation requires

intensive capacity strengthening and hand holding for quality control for the trained personnel on the current kiln. Thus a longer term support program is imperative to achieve scale and impact that the technology transfer pilot envisions. With the backdrop of these assumptions, we can chart a course of widespread impact in the lives of the local Malawi home owners and entrepreneurs.

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