REDUCING EXPOSURE TO INDOOR AIR POLLUTION THROUGH HOUSEHOLD ENERGY AND BEHAVIORAL IMPROVEMENTS

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List of Acronyms

ARI	Acute Respiratory Infection
ALRI	Acute Lower Respiratory Infection
ARECOP	Asia Regional Cookstove Program
ARTI	Appropriate Rural Technology Institute
CCT	Controlled Cooking Test
CEPIS	Center for Sanitary Engineering and Environmental Sciences
CO	Carbon Monoxide
COPD	Chronic Obstructive Pulmonary Disease
EHA	Environmental Health Association ("Association")
EHC	Environmental Health Committee ("Committee")
GTZ	German Technical Cooperation
GVEP	Global Village Energy Partnership
IAP	Indoor Air Pollution
KEFRI	Kenya Forestry Research Institute
MPA	Methodology for Participatory Assessment
NGO	Non-Governmental Organization
PAHO	Pan American Health Organization
PCIA	Partnership for Clean Indoor Air
PM	Particulate Matter
USAID	United States Agency for International Development
VERC	Village Education Research Center
WHO	World Health Organization

Executive Summary

This report presents the outcomes of the USAID-funded work undertaken by Winrock International aimed at promoting the sustained adoption of technologies and practices to improve indoor air quality in the developing world with a commensurate reduction in associated health impacts among those most at-risk − young children and women. The first phase of the program (2003-2004) supported work in Kenya and the Philippines, and informed the activities undertaken during a second phase (2004-2007), which was comprised of integrated household energy and health pilot projects in Bangladesh and Peru.

The objective of this work was to support sustained adoption of improved energy technologies and practices to improve indoor air quality for the urban and rural poor, and thereby reduce associated health impacts for those most at-risk, especially young children and women. The program goal in support of this objective was to develop and demonstrate models for sustainable improvement of indoor air quality through fuel, stove or housing improvements, coupled with behavior interventions.

The program was intentionally based on a market-based approach, not incorporating any technology subsidization; this was seen as an important step for improved technologies to be successfully adopted both in the short term and beyond the life of external aid. This approach was complemented by a strong communications campaign, including a range of behavior change and social marketing messages to raise awareness of the health risks of indoor smoke and appropriate measures that families can take to mitigate those impacts.

Key program components include:

- Improving access to improved hardware and fuels: ensuring that improved cooking technologies and fuels, as appropriate, are cleaner and more efficient compared to existing cooking methods; appropriate to meet local cooking needs; and cost effective and available to the target population through local production and distribution channels.
- Promoting effective behaviors by combining technology promotion with awareness-building about messages which resonate within the local culture, respond to felt needs, and provide the recipients with the knowledge, ability and motivation to change their behavior to reduce harmful health and other effects of cooking smoke and to improve their lives in tangible ways.
- Improving the enabling environment by focusing on community-based organizations, local entrepreneurs, and locally-managed micro-finance to lay the foundation for sustainable market growth, while also engaging policymakers, NGOs and other stakeholders at the municipal, state and

national levels to raise awareness of the impacts of indoor air pollution on the public health burden and raise interest in solutions.

- Monitoring indoor air pollution (IAP) and other health and socio-economic indicators, to validate the effectiveness of the intervention in achieving IAP reductions and associated benefits.

In the Philippines, Winrock undertook an exploratory study on household energy, indoor air pollution, and perceptions of health impacts with two primary objectives: 1) to determine the extent which indoor air pollution from cooking practices represented a serious problem meriting consideration of a household energy intervention in this region; and, 2) to pilot survey and monitoring instruments for further use in the design and evaluation of other household energy interventions. The results of the study suggest that indoor air pollution from cooking does not represent a serious health risk to women and children in the targeted areas, despite the fact that nearly 75% of women surveyed cook with biomass over indoor open fires; this result is likely due, in part, to adequate ventilation of kitchen spaces. Fuel efficiencies gained through utilization of improved technologies may, in and of themselves, present a valid rationale for their adoption. The pilot survey and monitoring instruments tested in the Philippines were then refined for application in Peru and Bangladesh.

In Kenya, Winrock assisted two groups of women entrepreneurs to strengthen their improved cookstove manufacturing and sales capability, including through social marketing of their products. The primary objective of this activity was to reduce exposure to indoor air pollution generated by inefficient cooking devices in peri-urban slums of Nairobi, and to improve the livelihoods of participating households through the development and promotion of women entrepreneurs. This small-scale campaign trial yielded a greater awareness of and significantly increased demand for the improved hardware for cooking, and generated useful lessons learned regarding the need to increase the focus of the messaging on the links between indoor smoke and specific health impacts.

Based on Phase 1 activities undertaken in the Philippines and Kenya, and guided by the key program components, two pilot projects were developed for Phase 2: 1) Bangladesh – Commercialization of Improved Woodstoves for Reduced Indoor Air Pollution in Urban Slums of Northwest Bangladesh; and, 2) Peru – Healthy Kitchen/Healthy Stove: Indoor Air Pollution Exposure Reduction through Household Energy and Behavioral Improvements among Families of the High Andes District of Inkawasi, Department of Lambayeque, Peru.

In Bangladesh, Winrock worked to reduce indoor air pollution and fuel consumption via the dissemination and commercialization of improved cookstoves among peri-urban communities through an integrated and sustainable household

energy intervention. The project aimed to establish a sustainable market for improved and appropriate stoves to avoid the need for subsidies. The pilot coupled improved stove promotion with a multi-faceted communication campaign aimed at raising awareness about the risks of indoor smoke and the benefits achievable through behavior change and using improved stoves to reduce IAP exposure. The project team worked with existing local government institutions and health networks to disseminate behavior change messages, and teamed up with local entrepreneurs to sell stoves commercially. Project activities resulted in 583 households gaining access to improved cookstoves; IAP-related awareness-raising messages disseminated to over 50,000 people; increased commitment from the local government to mitigate indoor air pollution; and more than 25 cookstove entrepreneurs established or supported to continue the marketing of cookstoves in Bangladesh beyond completion of the pilot project.

The Peru "Healthy Kitchen/Healthy Stove" project was implemented in the rural district of Inkawasi in the northern department of Lambayeque, in the high Andes. The project had three objectives: achieving a significant reduction in IAP levels within the kitchens of participating households; establishing a sustainable market for improved and appropriate stoves to avoid the need for subsidies; and, ensuring that stoves would be available to the villagers beyond the project period. Given the region's lack of a cash economy, this was achieved in part through an innovative income-generating animal husbandry-based micro-finance mechanism. The pilot coupled product promotion with a multi-faceted communication campaign to raise awareness about the risks of indoor smoke and to introduce improved stoves and specific behaviors as effective tools for reducing exposure. The 21-month project resulted in reduced indoor air pollution, and community ownership and management of the production, promotion, micro-financing, and broad dissemination of improved "Inkawasina" stoves.

Important **project management lessons** learned included: 1) the need for specialists to guide and complement local implementer capacity; and 2) the need for careful monitoring of the sequence and timeline of implementation activities, as well as 3) having an in-country project manager for timely coordination and support.

Based on experiences with activities geared toward improving access **to improved hardware and fuels**, Winrock recommends that awareness raising, social mobilization and entrepreneur development should only proceed once final technology choices based on local practices and preferences are made. Quality stove components are critical, including appropriate materials and production methods especially for combustion elbows, as are crucial communications with users on stove maintenance and fuel preparation.

Winrock's experience with **social mobilization activities** shows that consolidating a presence in a manageable number of villages and achieving a sustainable administration system before attempting to reach out to additional communities is needed to prevent overextension. Messages, whether written, spoken or relayed through pictures, should be developed through a participatory process, and a mix of media (including printed materials, direct engagement; films and musical performances; road shows and demonstrations; radio programs) can effectively address a broad range of audiences.

***Sustained results are the true test of success**: The integrated models implemented in Bangladesh and Peru were successful in achieving sustained technology adoption and significant reductions in indoor air pollution – they also succeeded in establishing robust non-subsidized locally-developed improved stove markets.*

To improve the **enabling environment**, it is important to focus on building effective community-based organizational infrastructure, empowering local entrepreneurs, and increasing access to improved stoves through appropriate micro-finance, as well as engaging local policy-makers and other stakeholders prior to and throughout implementation. A strong enabling environment can provide incentives and other means to facilitate and catalyze market mechanisms.

The integrated energy and health intervention models implemented in Bangladesh and Peru were successful in achieving sustained technology adoption and significant reductions in indoor air pollution, including through improved behaviors. Even more importantly, they succeeded in establishing robust non-subsidized locally-developed improved stove markets in two very different geographic, cultural and socio-economic settings, both of which have continued and in fact prospered long after project completion – in both cases entrepreneurial activities and stove purchase and installation have increased significantly following the formal end to the project period. With effective models established and important lessons learned along the way in program design, implementation and evaluation that will serve to inform future activities, the next step will be to replicate and scale-up the models beyond the initial pilot demonstration stage.

Building on lessons learned under the program detailed here, follow-up initiatives should ensure programs are based on sound, tested technologies combined with social marketing; proper sequencing of program activities; microfinance options appropriate for target populations; a strong promoter network when possible, using volunteers where appropriate; and, regular monitoring of results beyond the formal project implementation timeline with resources available for any follow-up subsequently required.

1. Program Overview

1.1. Background

This document presents the outcomes of work performed by Winrock International promoting sustained adoption of technologies and practices to improve indoor air quality in the developing world and reduce associated health impacts among those most at-risk − young children and women. Work progressed in two phases. The first phase, undertaken from 2003-2004, explored the role of household energy and indoor air pollution in Kenya and the Philippines under the USAID-supported program, *"Increased Use of Renewable Energy Resources."* The results and lessons learned during Phase 1, primarily from the piloting of indoor air pollution (IAP) and household energy monitoring tools, informed program activities under the second phase.

*Some **3 billion people** in the developing world use coal and wood for heating and cooking in ways that release dangerous particulate matter, resulting in indoor air pollution levels 20 to 100 times greater than recommended by WHO.*

Phase 2 took place from 2004-2007 under a subsequent USAID program *"Reduction of Exposure to Indoor Air Pollution through Household Energy and Behavioral Improvements,"* and supported two integrated household energy and health pilot projects in Bangladesh and Peru. These pilots aimed to reduce indoor air pollution using strategies promoting improved cooking technologies and practices that hold promise for future replication and scale-up. The second phase built on and complemented first phase activities, as well as activities undertaken through two global partnerships: the Global Village Energy Partnership (GVEP) and the Partnership for Clean Indoor Air (PCIA). USAID has been a core contributor toward, and Winrock a leading partner in, both of these partnerships.

Household energy use is connected to virtually all of USAID's development sectors and activities, including economic growth, natural resource protection, and human health. The EGAT Bureau's Energy Team and the Bureau for Global Health's Environmental Health Team agreed to jointly support efforts to improve the availability, efficiency and sustainability of household energy

use, while at the same time reducing the negative health impacts associated with household energy consumption.

Some three billion people in the developing world use coal and biomass for heating and cooking over open fires, or with rudimentary stoves. These methods result in the release of dangerous particulate matter, carbon monoxide, and other toxic pollutants — as well as greenhouse gases — into the air. The resulting indoor air pollution levels are 20 to 100 times greater than standards recommended under the World Health Organization's (WHO) air quality guidelines. WHO estimates that exposure to indoor smoke from burning solid fuels causes an estimated 1.5 million premature deaths each year, mainly from pneumonia in children and chronic obstructive pulmonary disease (COPD) in women. In fact, indoor air pollution from household energy is ranked fourth in the list of serious threats to health in less developing countries, after malnutrition, unsafe sex, and unsafe water. Globally, acute lower respiratory infections, closely associated with exposure to indoor smoke (including pneumonia) represent the single leading cause of death in children under five years; every year, indoor air pollution is responsible for nearly 800,000 deaths due to pneumonia among children in this age group. [1]

Health impacts associated with exposure to indoor air pollution include acute respiratory infections (ARI), including pneumonia; chronic obstructive pulmonary disease (COPD), such as chronic bronchitis; lung cancer (for users of open coal stoves); cataracts; tuberculosis; asthma attacks; adverse pregnancy outcomes (stillbirth, low birthweight); and early infant death.[2]

Until relatively recently, the issue of indoor air pollution and the associated burden of morbidity and mortality received little systematic attention at the international level among both donors and international agencies. Since 2002, a number of groups recognizing the severity of health impacts from IAP have invested significant resources to raise awareness and develop effective approaches to address the issue. The WHO's World Health Report 2002 put indoor air pollution "on the public health map." The launch of the Partnership for Clean Indoor Air (PCIA) at the World Summit on Sustainable Development in Johannesburg in August 2002 drew further attention to the issue, and reflected a commitment by the U.S. Government to seek sustainable solutions to the energy, health and overall economic implications of household cooking practices. Through the collaborative efforts of its Health and Energy Offices, USAID sought to demonstrate integrated approaches to household energy use

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[1] *World Health Organization, World Health Report 2002; http://www.who.int/indoorair/health_impacts/en/*

[2] *Smith, K.R. Indoor air pollution in developing countries: recommendations for research. Indoor Air 2002; 12: 198–207.*

that would provide health benefits, as well as positive poverty reduction impacts, through increased efficiency of cooking fuels, technologies and practices.

1.2. Program Objectives

USAID's overall objective was to support the sustained adoption of improved energy technologies and practices to improve indoor air quality for the urban and rural poor, and thereby reduce associated health impacts for those most at-risk, especially young children and women. Toward this objective, Winrock's task was to develop and demonstrate models for the sustainable improvement of indoor air quality through fuel, stove or housing improvements, coupled with behavior interventions. Such models would better position USAID-assisted countries in the scaling-up of selected interventions.

1.3. Approach

Recognizing the deficiencies in large-scale, technology-driven "improved stoves" programs of past decades, this program strove to demonstrate more effective approaches to achieving long-term adoption of improved cooking technologies and reduced exposure to kitchen smoke. First and foremost, USAID and Winrock agreed that, for improved technologies to be successfully adopted both in the short-term and beyond the life of external aid, a market-based approach incorporating microfinance (as appropriate) would be critical. Such an approach would, in turn, need to be complemented by a strong communications campaign, including a range of behavior change and social marketing messages to raise awareness of the health risks of indoor smoke (and other identified drivers for adoption) and appropriate measures that families can take to mitigate the negative health impacts.

Phase 1 activities were limited, and were aimed at gleaning lessons learned to be applied to integrated Phase 2 pilots, as part of the overall approach previously described, and all in support of the specific components described in the following text. These Phase 1 activities and lessons learned focused on developing and testing survey and monitoring tools in the Philippines, where another USAID-funded energy project was being implemented by Winrock, and the piloting of social marketing materials and strategies for commercializing and promoting improved cooking technologies in Kenya. An important goal of this phase was the validation of the monitoring and other data collection tools and protocols, both for use in the Phase 2 pilot projects, as well as for the design and evaluation of other household energy and health interventions to be undertaken in the future by USAID and other organizations. To that end, refinement and further validation of the tools and

protocols, including IAP monitoring, household surveys, focus groups and social marketing materials and approaches, constituted another important element of the Phase 2 pilots.

The components described below reflect USAID and Winrock's vision of key elements that must be employed for any sustainable and successful household energy and health initiative.

1.3.1. Access to improved hardware and fuels

This component focuses on ensuring that improved cooking technologies and fuels, as appropriate, are: indeed cleaner and more efficient compared to existing cooking methods; are appropriate to meet local cooking needs; and, are cost effective and available to the target population through local production and distribution channels. This program aimed to identify places where one or more improved stoves and other technologies (e.g. retained heat cookers) either already existed but were not in widespread use due to lack of an effective business model, or where one or more stoves promoted in prior initiatives could be further improved with minor modifications. Either case requires technical assistance to ensure the best possible performance with the least expensive materials, and the development or strengthening of local production capacity and quality assurance.

1.3.2. Promotion of effective behaviors

One of the lessons learned from numerous improved stove programs is that, contrary to a popular notion that "all we need is a better stove," the technology itself is only one part of the solution. If and how that technology gets used can be just as important, if not more so. A stove that performs beautifully under lab conditions will be neither efficient nor smoke-reducing if the user routinely uses damp fuel wood. Thus, it is critical to combine any technology promotion with awareness-building about the key issues related to improving cooking practices. Messages must be developed that resonate within the local culture, respond to felt needs, and provide the recipients with the knowledge, ability and motivation to change their behavior to effect an improvement in their lives in tangible ways. Specifically, the project's messages aimed to educate people about the harmful health effects of cooking smoke, and about how they could reduce these effects (and obtain other benefits, such as time and fuel savings) through improved technologies and behaviors. Even in cases in which health is shown to be less of a driver than other benefits in stove adoption, health-focused

messages can successfully encourage beneficial behavior change to mitigate exposure when users better understand exposure impacts. Given this project's inherent goal of technology adoption, much of the behavior change communications were linked to the social marketing of a specific cooking device. The messages were further refined and reinforced through community participation—from focus groups to radio dialogues, to folk songs and road shows.

1.3.3. Improving the enabling environment

A sustainable market for cleaner fuels and improved stoves is facilitated by supportive government policies, legislation, regulatory frameworks, institutions and financing options. The more these elements exist, the more chances a market approach will have for success. However, most developing countries lack a supportive environment for poor populations to move up the energy ladder or otherwise access improved cooking devices. Under favorable conditions, some of these supportive elements, such as local institutions and innovative finance schemes, can be established in the relatively short term, while government policies and regulatory frameworks generally require more substantial inputs and timeframes to change. Through each Phase 2 project, Winrock placed its greatest focus on community-based organizations, local entrepreneurs, and locally-managed micro-finance to lay the foundation for sustainable market growth. At the same time, Winrock sought multiple venues for engaging policymakers, NGOs and other stakeholders at the municipal, state and national levels to raise awareness of the impacts of indoor air pollution on the public health burden, as well as impacts on time savings, opportunity costs and natural resource damage, and raise interest in solutions by sharing the progress and results of the household energy and health intervention models underway.

1.3.4. Indoor Air Pollution (IAP) monitoring

There is a growing base of data on incidence of acute respiratory illness among children and infants, and a smaller but gradually increasing base of data on indoor air pollution. Studies linking IAP exposure reduction to specific health impacts are few, as the research involved is difficult and costly, but proxy data based on the research done to date[3] can allow

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[3] *Most notably Smith-Sivertsen, et al, Reducing indoor air pollution with a randomised intervention design –A presentation of the Stove Intervention Study in the Guatemalan Highlands; Norsk Epidemiologi 2004; 14 (2): 137-143), also as referenced in Smith, K.R. Indoor air pollution in developing countries: recommendations for research. Indoor Air 2002; 12: 198–207 for the health impacts associated with indoor air pollution exposure noted on page 6.*

intermediate evaluation of program impact. In Peru, Winrock utilized pre- and post-intervention monitoring of particulate matter (PM) and carbon monoxide (CO) concentrations within the cooking area to verify the reductions achieved through the integrated interventions. In Bangladesh, stove emissions of PM and CO were measured in the lab and in homes. While few implementing NGOs have IAP monitoring experience the equipment is expensive, and there remains a lack of consensus on standard exposure monitoring protocols, Winrock recognizes the importance of intervention monitoring for policymakers, program implementers and donors who depend on reliable information to make educated decisions about where and how to invest resources.

USAID and Winrock sought to identify favorable conditions where these program elements could be developed relatively quickly. Key considerations included: severity and scale (in terms of the size of the affected population) of the problem relative to donor resources dedicated to its solution; appropriateness of program design to meet local needs; existing local capacity for partnership; potential for leveraging activities and efforts via strategic partnerships; existence of an effective multi-sector platform; and, potential for USAID Mission interest. The team also aimed to trial both urban- and rural-focused projects, and to achieve a balanced geographical distribution. Guided by these considerations, the following two pilot projects were developed:

- Bangladesh – Commercialization of Improved Woodstoves for Reduced Indoor Air Pollution in Urban Slums of Northwest Bangladesh; and
- Peru – Healthy Kitchen/Healthy Stove: Indoor Air Pollution Exposure Reduction through Household Energy and Behavioral Improvements among Families of the High Andes District of Inkawasi, Department of Lambayeque, Peru

These two pilots were chosen from among a larger group of identified possible interventions, using a weighted ranking evaluation system that relied on the key considerations developed by the Winrock/USAID team.

Bangladesh was an especially attractive pilot option because of the history of past problematic household energy programs that focused on fuel wood savings; a serious lack of donor attention to this issue, especially from a health perspective; and the presence of strong local

partners with relevant experience, as well as potential links with ongoing USAID Child Health and Survival program activities.

The Peru pilot presented an opportunity to strengthen and expand a small but very successful GTZ/PAHO environmental health pilot intervention that showed clear promise for effectively reducing IAP in some of the most affected and vulnerable communities in the region. The presence of strong local partners that had already been involved in a similar intervention, as well as the high potential for replication throughout South America, were also attractive.

2. Program Details and Results

This section presents the results from the following program activities:

Phase 1 Program Activities

- Philippines – Exploratory Study on Household Energy Practices, Indoor Air Pollution and Health Perceptions in Southern Philippines; and
- Kenya – Indoor Air Pollution Reduction Initiative: Helping Women Entrepreneurs Commercialize Low-Cost Cooking Products in Peri-Urban Settlements Through Social Marketing

Phase 2 Program Activities

- Bangladesh – Commercialization of Improved Woodstoves for Reduced Indoor Air Pollution in Urban Slums of Northwest Bangladesh[4]; and
- Peru – Healthy Kitchen/Healthy Stove: Indoor Air Pollution Exposure Reduction through Household Energy and Behavioral Improvements among Families of the High Andes District of Inkawasi, Department of Lambayeque, Peru[5]

2.1. Philippines

2.1.1. Background

Winrock International undertook an exploratory study on household energy, indoor air pollution, and perceptions of health impacts in Southern Philippines, with two primary objectives: 1) to determine the extent to which indoor air pollution from cooking practices represented a serious problem meriting consideration of a household energy intervention in this region; and, 2) to pilot survey and monitoring instruments for use in the design and evaluation of household energy interventions in the Philippines, and/or in other country contexts. The study involved 120 households across 3 areas in which Winrock

[4] *http://pdf.usaid.gov/pdf_docs/Pnado851.pdf*

[5] *http://pdf.usaid.gov/pdf_docs/Pdacn009.pdf*

implements the USAID/Philippines-supported Alliance for Mindanao Off-grid Rural Electrification Project (AMORE).

2.1.2. Approach/Activities

For this study, Winrock worked with local Winrock and AMORE staff, an experienced IAP researcher, a local university scientist with lab facilities, and a focus group consultant to develop and conduct a household energy practices and health perceptions survey, indoor air pollution baseline measurements, and a series of focus groups in the target communities. Winrock developed the survey to assess household fuel use and cooking patterns, as well as to gather information on local knowledge, perceptions and attitudes towards indoor air pollution and possible ways to reduce exposure to smoke. The survey, based on the Intermediate Technology Development Group's smoke and health study, adapted to local conditions and reviewed by experts in related fields, contained seven main categories: households' socio-economic condition; cooking practices; cooking technologies; fuel use; health perceptions; and a final section for enumerator observations on house and kitchen characteristics.

2.1.3. Results

The results of the study suggest that indoor air pollution from cooking does not represent a serious health risk to women in the targeted areas, despite the fact that nearly 75% of women surveyed cook with biomass over indoor open fires. The indoor air pollution (IAP) monitoring conducted in a subset of 30 households revealed relatively low 24-hour average area concentrations of particulate matter (measured as PM_4) and carbon monoxide: 72 $\mu g/m^3$ and 1 ppm, respectively[6]. Personal exposure monitoring of CO, which can be used as a proxy for PM from biomass smoke[7], also revealed very low 24-hour averages (1 ppm). That said, peaks of acute exposure were evident during cooking times,

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[6] *By comparison, the US Environmental Protection Agency's (USEPA) 2006 ambient air quality standard for PM for a 24-hour average 35 $\mu g/m^3$; revised from the previous level of 150 $\mu g/m^3$. USEPA's recommended 8-hr exposure limit for CO is 9ppm. Concentrations of upwards of 10-20 times these limits is not uncommon in many homes in which solid fuels are burned in open fires or in rudimentary stoves.*

[7] *CO has been shown in several studies to be highly correlated with PM levels, and in fact was used as such in the first randomized controlled trial ever on health effects of solid fuel use, led by University of California, Berkeley and primarily funded by the U.S. National Institutes of Health. (Smith-Sivertsen, et al, Reducing indoor air pollution with a randomised intervention design –A presentation of the Stove Intervention Study in the Guatemalan Highlands; Norsk Epidemiologi 2004; 14 (2): 137-143).*

typically ranging between 20-40 ppm at these times, with instantaneous peaks up to nearly 200 ppm.

The focus group discussions, the survey on household energy practices, indoor air pollution and health perceptions, and the IAP monitoring protocols proved to be an effective combination of instruments for assessing both the actual IAP levels in typical households, and the broader conditions and perceptions of the women in relation to their cooking environments. This pilot activity enabled the identification of several specific ways in which each instrument and its respective application could be improved with modest changes to ensure greater efficiency and accuracy of data collection and processing, thereby enabling them to be adapted for use in developing and monitoring future household energy and health interventions in the Philippines or other similar country contexts.

2.1.4. Conclusions

A number of factors could explain the relatively low levels of indoor pollutants in this region, including physical characteristics such as adequate ventilation of kitchen spaces. From the data and these observations, the team concluded that women's and children's exposure to indoor air pollution is not likely a major health risk in this area, and thus did not recommend that a household energy and health intervention be incorporated into the broader AMORE project.

Despite this conclusion, the Winrock team recommended that project leaders take into consideration the broader health, socio-economic and natural resource impacts of the population's dependence on biomass, and the extent to which the population perceives a need for improved conditions. The study did reveal that the primary cooks in the family (women aged 16 to 60) do perceive that smoke and heat from cooking fires is detrimental to health or can aggravate common symptoms. There was also recognition that fuel wood gathering is a weekly burden, resulting in both pressure on nearby mangroves and purchase of fuel wood where it is scarce. Cleaner fuels, including LPG, were present in a number of homes, but only infrequently used due to the cost and limited availability in some cases. Thus, the introduction of cleaner and more efficient biomass stoves would help to address a perceived health problem, and reduce time, financial costs and energy spent collecting biomass, as well as pressures on a tenuous natural resource base.

2.2. Kenya

2.2.1. Background

Winrock's activities in Kenya, funded by USAID and co-funded by the Shell Foundation, focused on assisting two groups of women entrepreneurs to strengthen their improved cookstove manufacturing and sales capability, including through social marketing of these products. The primary objectives of this activity were to reduce exposure to indoor air pollution generated by inefficient cooking devices in peri-urban slums of Nairobi (although this activity did not incorporate IAP monitoring), and to improve the livelihoods of participating households through the development and promotion of women entrepreneurs.

Winrock had previously worked on a very modest basis with the two women's groups, in response to concern about the common use of plastics for cooking fuel, with support from USDA. USAID and Winrock perceived an opportunity to leverage the Shell Foundation's nation-wide Breathing Space program[8] by developing and pilot-testing social marketing materials tied to improved cooking devices within the target market of the women's groups, with future use on a nationwide basis. Thus, the longer-term goal of this work was to facilitate scale-up production and marketing of appropriate, clean and efficient cooking appliances in peri-urban settlements, within the broader context of the Breathing Space program.

2.2.2. Approach/Activities

In support of these activities, Winrock-Nairobi staff worked with its long-time partner, Kenya Forestry Research Institute (KEFRI) and trainers from the Ministry of Energy to provide business development support to the women's groups starting in July 2004, including: production training for the ceramic-lined Maendeleo jiko stove and retained heat cooker ("haybasket"); assistance in sourcing clay, baskets and other materials; construction of 2 kilns and instruction on firing of ceramic linings; training in leadership skills, gender group dynamics, basic bookkeeping and other business skills; and a one-time capital infusion of US$2,500 per group to cover business start-up costs. In

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[8] *The Breathing Space initiative was launched in 2002 to achieve a significant long-term reduction in IAP by helping develop technology to make stoves more emission and fuel efficient - and by developing a sustainable way to get them in to people's homes through market-oriented and commercial viable approaches.*

parallel, Winrock contracted a social marketing firm based in Nairobi (The Steadman Group), to conduct baseline consumer research to evaluate resulting communication strategies, and to evaluate the impact of the consequent social marketing interventions through baseline surveying completed in 2004, and post-intervention surveying in 2006. Winrock also hired Nairobi-based Ace Communications to develop the social marketing materials and campaign based on Steadman's findings and recommendations.

Ngong women's group members make Maendeleo jiko stove liners

Women's group members shows off fresh steamed rice in haybasket

The social marketing messages developed by Ace initially reflected the results of Steadman's consumer research. Cost (maintenance costs, fuel costs, and especially initial investment cost) was found to be the primary driver behind cooking device purchasing decisions. Other influencing factors included availability of the appliance and of the required fuel in the local market, cleanliness, ease of use and lighting. Increasing kerosene costs and a local ban on charcoal use led to increased interest in improved cooking appliances.

Notably, health considerations related to cooking did not emerge as consumer influencing factors in Steadman's baseline. This is understandable, given the common lack of awareness of the serious health impacts associated

Social marketing boosts demand in Nairobi: *In the 16 months between December 2004 and February 2006, the Kenyan women's groups had sold 200 stove liners and 110 haybaskets. In less than 3 months following the social marketing campaign, the groups sold 100 liners and 35 haybaskets.*

with exposure to cooking smoke. Because a core objective of the campaign was to raise awareness of these health risks, the negative impacts of IAP on the health of women and children health was included among the key messages. However, the results of Steadman's pre- and post-campaign research revealed that health continued to be only a minor driver in new purchases. The top five motivations for fuel and technology choices for both those exposed and not exposed to the social marketing campaign were: the (daily use) fuel is cheap; the fuel is readily available; the technology is affordable (low initial investment cost); the fuel lights up easily; and, the technology is easy/simple to use.

On the positive side, results also showed that those exposed to the social marketing campaign showed a greater likelihood to consider health implications when choosing a cooking appliance.

Top five motivating factors for fuel and technology choices:

- *The fuel is cheap (daily use fuel)*
- *The fuel is readily available*
- *The technology is affordable (low initial investment cost)*
- *The fuel lights up easily*
- *The technology is easy/simple to use*

Campaign strategy

The social marketing campaign ran for 1 month, from early February to early March, 2006. The women's groups actively participated in planning and running the campaign, which involved a range of activities in 4 towns within the Kajiado District where the women's groups are active. These included:

- Community dissemination events (road shows) that incorporated music, dancing, drama, question and answer sessions and demonstrations;
- Radio spots, interviews and talk shows;
- Demonstrations by the women's groups on how to use the cooking appliances and testimonials by users; and
- Dissemination of information, education and communication (IEC) materials, including posters, banners, fliers, stickers and T-shirts

The radio shows included interviews with the women entrepreneurs, and half hour-long programs inviting call-in questions from listeners. The road shows were conducted by

professional actors from an entertainment firm, Factual Films, who received 3 days of training on the appliances and the social marketing messages.

2.2.3. Results

By achieving scaled-up production and dissemination of appropriate, clean and efficient cooking appliances, and strengthening the capability of women entrepreneurs in their manufacture and sales, this activity was able to meet both the objectives of a reduction in exposure to indoor air pollution, and an improvement in the livelihoods of participating households.

Campaign results

Overall, the social marketing campaign appears to have been quite successful, considering its short duration. The campaign prompted a number of on-site sales, as well as a post-campaign surge in demand for the products. In the 16 months between December 2004 and February 2006, the women's groups had sold 200 stove liners and 110 haybaskets. In less than 3 months following the campaign, the groups sold 100 liners and 35 haybaskets.

Steadman's research affirmed that, while several barriers remain (most notably cost), awareness of and demand for the products increased significantly. Following the social marketing campaign, unaided and aided product recall increased by nearly 20%, while use of the stoves increased by 6 fold and doubled for the haybaskets. Overall interest in the products (as indicated by traders who cite orders from big chain supermarkets) rose, and a higher awareness of the negative impacts of cooking appliances as well as a greater intention to use the improved appliances were reported by those exposed to social marketing activities compared to those not exposed.

Despite the campaign's emphasis on the advantages of the improved cooking appliances, however, it had little impact on awareness of the link between the cooking appliances and indoor air pollution and health (respiratory diseases). There was no significant difference between the groups exposed to social marketing versus those not exposed in terms of awareness of the relationship between indoor air pollution and respiratory infections in children under 5 years. This may reflect the fact that urban consumers are most interested in perceived economic benefits, but may also reflect shortcomings in the social marketing campaign's behavior change messages and communications.

Potential for future impact

This small-scale campaign trial yielded several positive, tangible results, most importantly a greater awareness of and demand for the improved hardware for cooking. It also generated useful lessons learned regarding the need to increase the focus of the messaging on the links between indoor smoke and specific health impacts, as well as other lessons and recommendations which are discussed in more detail later on in this report.

Unfortunately, the immediate benefits to the women's groups, and the broader value of this social marketing campaign trial were significantly reduced due to initial delays in the launch of the Breathing Space program. Changes in the approach of the Breathing Space program subsequently resulted in the Shell Foundation withdrawing completely from originally planned program activities, all of which caused serious disruption for Winrock's partners and the women entrepreneurs. Their work was strategically timed with the broader program, and their budget was reliant on the promise of joint funding. Given that they had been counting on the marketing to support their product sales, many women ended up dropping out of the entrepreneur groups. This outcome is a risk when coordinating with external activities, and the benefits of the leveraging must be weighed against the potential complications if funding falls through or agreements aren't reached.

In addition, the Winrock team had planned to apply the learnings from Kenya in the development of behavior change and social marketing messages and materials for the Peru and Bangladesh projects, but in each case the pilots well underway by the time the Kenya reports were finalized, and hence the development of the pilot communications messages and materials development had to take place before key lessons could be extracted from Kenya.

2.2.4. Conclusion

Based on the Kenya experience, Winrock would now recommend a greater messaging focus on the links between cooking appliances and specific health impacts, that social marketing campaigns be planned to last at least several months, and that these campaigns focus on in-person networking and demonstrations as well as radio programming, and less on printed materials. This finding was echoed in the Phase 2 pilots.

At the end of the Kenya activities, Winrock still felt that further strengthening of the women's groups was needed via training to improve quality control, branding and cost effective production, so that

the groups can both meet demand and overcome potential future competition. Similar experiences were felt in the Phase 2 pilots, leading Winrock to suggest that more business-savvy groups or individuals be selected to undertake such interventions in the future, or specialists hired to provide more in-depth targeted guidance and support, or to take on stove production and sales themselves.

Another lesson from Kenya was that future implementation activities should address the cost-to-consumers barrier through identifying and facilitating access to credit; this issue was directly addressed in both the Bangladesh and Peru pilot projects, which incorporated microcredit as central components of project activities.

2.3. Bangladesh

2.3.1. Background

In Bangladesh, the majority of the population relies on biomass for cooking and heating. About 94 percent of the energy to meet household cooking needs comes from biomass sources. From a health perspective, acute respiratory infections (ARI) are one of the leading causes of under-five deaths in the country, which has an under-five mortality rate of 77 per 1,000 live births.[9] The Bangladesh Country Environmental Analysis (CEA)[10] states that respiratory infections and diseases from indoor air pollution results in 17 percent of Disability Adjusted Life Years[11] lost per capita.

The overall objective of this pilot project was to reduce indoor air pollution and increase energy efficiency through an integrated household energy intervention. The project area consisted of 5 wards corresponding to two peri-urban municipalities, Saidpur and Parbatipur, located in the Rajshahi-Rangpur area in northwest Bangladesh. The two municipalities have a total population of 136,000, spread over 24 wards. Biomass is the main source of household fuel,

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[9] *Mortality Country Fact Sheet 2006, World Health Organization. http://www.who.int/whosis/mort/profiles/mort_searo_bgd_bangladesh.pdf*

[10] *Bangladesh Country Environmental Analysis, Volume I: Main Report, August 23, 2006, South Asia and Social Development Unit, South Asia Region, World Bank.*

[11] *The Disability Adjusted Life Year or DALY is a health gap measure that combines in one measure the time lived with disability and the time lost due to premature mortality. One DALY can be thought of as one lost year of "healthy" life. http://www.who.int/healthinfo/boddaly/en/index.html*

primarily wood (47%), rice husk briquettes (18%), dung cakes (13%) and bamboo (11%), and smoke is a major health hazard. The vast majority of households earns between US$1-2 per day and spends 10-20% of income on fuel. There is little exposure to alternative technologies like improved cookstoves. Prior to the intervention, people knew that smoke was bad for them, but only in that it made them cough, and their eyes water; they had no awareness of any long-term or specific child health impacts. As with the Peru pilot, this project aimed to develop and demonstrate an integrated energy and health intervention model for future replication and investment on a larger scale.

2.3.2. Approach/Activities

Winrock selected peri-urban communities because of documented poor indoor air quality, supportive conditions for commercial activity, and a strong existing health communications network. In these areas, the high density of dwellings and of smoke that permeates shared walls built with bamboo mats, pieces of plastic, mud, and tin creates a common polluted air space that can only be remedied through an organized approach to technology and behavior change. Large portions of the Bangladeshi population live in such conditions. Further, the majority of households in the selected wards purchase fuel for cooking, which suggested a favorable environment for commercializing fuel-efficient stoves. In addition, these areas are largely inhabited by Bihari refugees who tend to be very entrepreneurial, with the majority of families involved in small businesses and women often earning small wages through embroidery. Finally, the municipalities chosen have active community health networks, called Ward Health Committees, capable of transmitting the core messages about the health risks associated with indoor smoke.

Smoky kitchen with traditional cookstoves in Saidpur

Case Study/Bangladesh - Improved cookstove business for household income: *Maya Khala is an energetic woman in her late forties. She was one of the early supporters of the project activities and has received training on improved cookstove construction and enterprise development. Even before the cookstove promotion activities, Maya was adept at making cookstoves and many women, particularly young housewives, would go to her to have their cookstoves made.*

When entrepreneurs started to construct cookstoves, Maya quite liked the idea of selling cookstoves for a small fee of Tk. 30 on an ad hoc basis for her family, neighbors, and friends. However; as the time, effort, and resources required for cookstove construction became apparent to her, she began to understand the importance of properly costing a cookstove and selling it at the correct price. Maya also took into consideration the time required for after-sales services. When Winrock started discussions with the entrepreneurs about the enterprise development process, Maya was one of the first women who embraced the idea of a cookstoves business and the link with sustainability and maintaining cookstove quality.

Maya Khala with chickens purchased with stove earnings.

Until recently, Maya had not taken loan from the seed fund as she was not convinced that she wanted to launch a fully fledged cookstove business. She was making a small profit and had purchased two chickens which she planned to raise over the summer for eggs. Eventually, as there was increasing interest in the cookstoves she constructed, she decided to take a small loan of Tk. 1,000 in July 2007.

Entrepreneurs like Maya have been the key drivers of the enterprise development activity, not only for their commitment to construct quality cookstoves but also for their enthusiasm for reducing indoor air pollution in the kitchens of their homes.

Winrock's strategy was to select two key partners with whom to work: one from the health sector, and the other with experience in improved stoves and participatory processes. Concern Worldwide Bangladesh ('Concern') has worked in Saidpur and Parbatipur for over 30 years and helped establish the Ward Health Committees in these cities under a still ongoing USAID child survival activity. In partnership with Winrock, Concern led the behavior change activities under this project. On the energy side, Winrock identified the Village Education Research Center (VERC), a local NGO with experience in community-based development, dissemination of improved stoves, a focal point for the

Asia Regional Cookstove Program (ARECOP), and a partner organization during the Government of Bangladesh-funded improved stove program in the 1980s. Under this project, VERC led the improved stove identification and commercialization activities.

In contrast to the Peru project, there was no obvious improved stove choice to promote in the Bangladesh slum areas. Winrock thus undertook a stove evaluation in parallel to the other core activities, seeking to identify an appropriate stove technology for these areas that would represent a significant improvement over the hand-made mud stoves commonly in use and which would be feasible given the restricted cooking spaces, rudimentary house construction, and close proximity to neighbors. Within these constraints, a highly-efficient, low-emission portable stove with no chimney appeared to be the most feasible and appropriate choice. Though the Government of Bangladesh had developed a limited number of biomass stove models for a nation-wide program in the 1980's, insufficient data was available to evaluate their performance; the stoves had not been tested for particulate matter emissions, as the focus of the Government stove program was biomass conservation. As such, the stove designs focused on fuel efficiency and not emissions reductions. Outcomes of the stove testing and selection process are detailed in the Results section below.

The Bangladesh intervention integrated the following components:

1. **Baseline assessment** to understand the current situation of household energy use and IAP in the communities. The assessment consisted of a household-level practices and perceptions survey, and IAP measurement of particulate matter ($PM_{2.5}$) and carbon monoxide (CO) concentrations. This assessment also provided a basis for target household selection.
2. **Social mobilization** to raise awareness about the adverse impacts of indoor air pollution, and mobilize households to adopt improved cooking technologies and practices. A key activity was the application of the Methodology for Participatory Assessment (MPA), a methodology adapted from the water and sanitation sector for use in improved stove promotion projects. While the full MPA was applied in this case, Winrock's experience indicates that a subset of the tools may be sufficient and preferable in future interventions. Other activities included courtyard meetings to provide a platform for households to discuss issues arising from project activities; education sessions targeting students and teachers from local schools and colleges and

including stove demonstrations, quizzes and general discussion on IAP; and, film shows for the broader community.

3. **Technology selection** to identify and select appropriate improved stoves through community participation, and emissions and efficiency testing. As part of the application of the MPA, VERC used participatory tools to collect consumer demand characterization information focusing on the types of stoves the community would like to use. This information was combined with information on available improved stove technologies in Bangladesh to develop a list of candidate stoves. VERC worked with the community to test the stoves by performing controlled cooking tests (CCT)[12]. Information from the CCT was combined with stove emissions and efficiency data to identify which improved stove models would be promoted in the project.
4. **Market development** to create demand and supply of improved cooking technologies. This component included training of entrepreneurs; establishment of a revolving seed fund for cookstove entrepreneurs to overcome entrepreneurial start-up costs; social marketing of stoves; and technical support for stove construction and quality control issues.
5. **Behavior change communication**, including the development and dissemination of behavior change messages to educate the populace about the impacts of IAP. Techniques included developing folk songs addressing behavior change for IAP reduction; orienting health volunteers on IAP and behavior change message dissemination; and introducing IAP related discussion in ward health committee meetings.
6. **Social marketing** to support the entrepreneurs with their stove businesses and inform potential buyers about the product available to them. The social marketing messages focused on the identification, benefits, use and maintenance of improved stoves. VERC developed billboards displaying the 3 types of improved stoves that have been promoted; laminated booklets with information on the 3 types of improved stoves and how to use and maintain them; and, posters containing the same information.
7. **Local government engagement** at every step of the project. The project team recognized early on that IAP is a new issue in the

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[12] *The controlled cooking test (CCT) enables comparison of cooking performance using the same quantities of food on multiple stoves.*

area and key stakeholders would need some orientation on the issue. Both Concern and VERC organized orientations for local government representatives and staff; involved municipal chairpersons, ward commissioners, and health officials in community mobilization activities; participated in ward health committee meetings to discuss project activities; and regularly updated key staff on project progress.

2.3.3. Results

To achieve the objective of a reduction in IAP and increased energy efficiency through the adoption/use of improved technologies, technology research and selection was first required.

Technology research

Following several months of stove identification and testing activities, for which support from the Appropriate Rural Technology Institute (ARTI) from India was contracted, the following 3 models of efficient and clean-burning stoves were identified for promotion in this project: (i) BSCIR[13] 1-pot portable stove; (ii) BCSIR 2-pot fixed stove with chimney; and, (iii) VERC-Grihalaxmi one-pot portable stove. The BCSIR 2-pot fixed stove with chimney has been the most popular stove, contributing to 65% of the stove sales, followed by the BCSIR 1-pot fixed stove (27% of sales) and the VERC-Grihalaxmi (7% of sales).

[13] *Bangladesh Council for Scientific and Industrial Research*

BCSIR 1 pot portable cookstove

BCSIR 2 pot fixed cookstove with chimney

VERC Grihalaxmi cookstove

All of the improved stoves showed a significant reduction in particulate matter, ranging from 39% to 84% per stove, and 65%- 99% reduction in carbon monoxide when compared to the traditional stove in an average 48-hour indoor air quality monitoring of kitchens. The BCSIR 1-pot portable model showed the most impressive performance, with an above 85% reduction in both CO and PM levels down to 0.36 ppm and 127 $\mu g/m^3$ respectively. The BCSIR 2-pot fixed model with chimney showed about 71% reduction in PM levels (down to 237 $\mu g/m^3$) and 99% reduction in CO levels (down to 0.2 ppm) when compared to a traditional stove. The BCSIR 1-pot portable stoves save, on average, 0.39 kg of fuel per day, leading to a monthly saving of over 11 kg of fuel. The fixed 2-pot model saved about 0.5-1 kg of fuel per day. Saving on fuel cost is particularly important for those households which purchase their cooking fuels. Local households spend, on average, Tk. 250-300 (US$3.50-4) per month on cooking fuel (up to a third of average income), which means a payback period of as low as 2-4 months, depending on the type of improved cookstove purchased, as the stove costs ranged from US$2-7.

Use of improved stoves

As of the end September 2007, a total of 583 improved stoves had been sold under the commercialization activity, surpassing the original target of 400 stoves. The team's strategy of focusing more on sustainable market mechanisms rather than simply reaching the installed stove target has been effective.

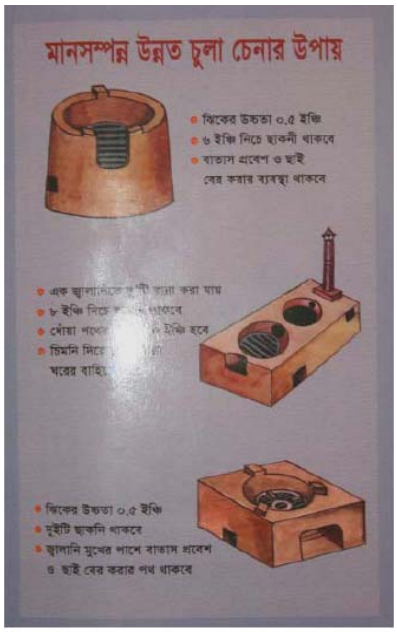
Through an emphasis on commercialization, the Bangladesh project supported 25 entrepreneurs, out of which 20 have taken loans from the seed funds, primarily to purchase cookstove accessories and tools. All entrepreneurs are women, many of them first time businesswomen. The entrepreneurs have continued to sell improved stoves beyond project closure in May 2007 and the number of stoves sold per month has increased steadily (as per monthly monitoring reports until September 2007), showing strong promise for sustainable stove sales moving forward. Users interviewed during the monitoring visits have reported they are happy with their stoves, and that the cookstoves are saving time and producing little or no smoke.

Communication campaign

The behavior change communication campaign included the development and dissemination of six messages which addressed ventilation, child care in the cooking area, proper fuel management, and cleanliness and hygiene in the cooking area. The messages were developed through a participatory process and field tested to ensure that they resonated with the household energy needs and concerns of the target households.

These messages were depicted in pictorial formats which were then printed on posters to address low literacy rates. About 200-300 posters were disseminated among local health clinics, health practitioners, local government institutions, health volunteers, and households. Concern also developed a folk song incorporating these messages, which was performed by a local folk song troupe and was hugely popular, attracting 200 – 250 people per performance. A total of 29 folk song sessions were performed during the project period. To disseminate the behavior change messages, Concern trained 30 health volunteers from its pre-existing network by giving them an orientation on IAP and behavior change message dissemination. Behavior change messages were also disseminated through Ward Health Committee meetings and all 5 committees in the project area have included the messages in their annual plan which lays out the health issues they will address in their respective wards in the coming year.

Folk song performance by Bina Pani in Parbatipur



Brochure depicting cookstove features

The project included a wide array of social mobilization activities, including participatory tools used in the MPA, courtyard meetings, education sessions and film shows. These activities were key in increasing awareness about indoor air pollution and building momentum for stove adoption. VERC organized a total of 216 courtyard meetings, education sessions, and film shows, respectively, during the project period. Each of the activities attracted a different segment of the community, ranging from target households to community leaders and local government representatives. This was an important factor for awareness raising, demand creation and community mobilization. While beneficiaries often cite cost savings from reduced fuel needs as a primary motivating factor in stove adoption, a close second is the high level of awareness achieved during the course of the project on the health impacts of indoor air pollution and mitigation measures, which has led to an increase in interest for improved stove adoption and has played an important role in sustaining the stove business beyond the project. Other motivations cited for stove adoption include kitchen cleanliness made possible by the reduction in indoor smoke, and time savings (cooking takes less time on the improved stoves). VERC's field staff was extremely dedicated and interacted with the community on a regular basis, addressing project dissemination issues, providing technical support for stove construction, and assisting the entrepreneurs.

Bangladesh Results Summary

Indicator	Result
Number of improved stoves purchased*	**583**
Average reduction in $PM_{2.5}$ emissions, compared to traditional stoves	
BSCIR 1-pot portable stove	**85%**
BCSIR 2-pot fixed stove with chimney	**71%**
VERC-Grihalaxmi one-pot portable stove	**39%**
Average reduction in CO emissions, compared to traditional stoves	
BSCIR 1-pot portable stove	**85%**
BCSIR 2-pot fixed stove with chimney	**99%**
VERC-Grihalaxmi one-pot portable stove	**65%**
Average household savings in fuel per day from improved stoves	**0.6kg**
Average household savings in US Dollars per day from improved stoves	**$0.05**
Number of entrepreneurs taking loans for improved stove businesses*	**20**

** Results as of September 2007*

These results are very encouraging, particularly given some early challenges in the project which stemmed from a general "subsidy mentality" within the project area and even among project stakeholders. Early on in the project, some stoves were sold at very low costs, and some households did not understand that the stoves were going to require payment. This was later rectified through the stove identification and testing process wherein the project partners made clear the costs involved in stove production, and reiterated the project's objective to recover these costs through small business ventures, and the need to establish a sustainable supply of improved stoves beyond the life of the project.

2.3.4. Conclusion

The pilot project focused on leveraging existing health networks and local government organizations to disseminate information related to improved stoves and behavior change practices. The IAP discussions in the WHC meetings helped to highlight the issue at the policy level, and to motivate WHC members, including ward commissioners, traditional birth attendants, teachers, NGO members, and other community leaders to take ownership of the project activities, raise awareness about IAP in other wards of Saidpur and Parbatipur, and commit to addressing IAP issues by promoting the entrepreneurs and monitoring health volunteers beyond the life of the project.

Commercialization of improved stoves was a key component of sustainability in this project. Establishing a market for improved stoves by fostering stove entrepreneurs ensured that there was a reliable supply of good quality, clean, and efficient improved stoves even after the end of the project. Monitoring visits conducted by VERC staff for 3 months after the end of the project suggested that the entrepreneurs continued to sell stoves and the project team expects that the stove businesses will continue to grow. Saidpur is a communication hub in the Northwest of the country and some of the entrepreneurs are getting orders from nearby districts, such as Rangpur and Thakurgaon, as well as from other areas of Nilphamari and Dinajpur districts where Saidpur and Parbatipur municipalities are situated, respectively, indicating that demand has been created beyond the project area.

Based on the project's success with stove sales and adoption, and effective promotion networks, Winrock believes the stove commercialization and behavior change communication components have very high potential for replication and scale-up. Concern has expanded its child survival project to seven additional municipalities in the Northwest region of Bangladesh. As these areas have very similar cooking and household energy practices, the stoves identified in Saidpur and Parbatipur would be very appropriate for these new urban centers. Given the interest in the improved stoves from nearby areas, scaling up the enterprise development activity should be relatively straight-forward and will help to establish stronger demand and supply chains. Concern led the behavior change message development and dissemination component of the project and as such would be most suited to scale up this component in the new municipalities where they are active. Similar to Saidpur and Parbatipur, these municipalities have established health networks and work very closely with local municipal governments.

Indoor air pollution received increased attention in recent years and organizations including the World Bank in Bangladesh and the World Health Organization are addressing the issue by developing IAP reduction pilot projects. Other organizations, such as Grameen Shakti, which has pioneered micro financing for renewable energy technologies in Bangladesh, have introduced improved stoves to their menu of household energy technologies including solar home systems and biogas plants. Winrock facilitated a meeting with Grameen and Appropriate Rural Technology Institute (ARTI), the Indian NGO that conducted the stove performance testing activity under the pilot project.

Additional details on the Bangladesh pilot intervention activities and results can be found in the referenced Bangladesh Pilot Report.

2.4. Peru

2.4.1. Background

Daily exposure to high levels of indoor smoke represents a serious health risk for the millions of indigenous poor who inhabit the high Andes. The situation is particularly severe at higher elevations, where cold temperatures and windy conditions lead people to cook almost exclusively indoors in poorly ventilated structures. According to the Ministry of Health, acute respiratory infection (ARI) was the leading cause of death in Peru in 2000. Peru's Country Environmental Analysis notes that IAP contributes to 25-40% of child ARI deaths in Peru; 20-30% of all ARI-related illness for children under five years of age; 15-25% of all ARI in adult females; and 20-40% of all cases of death and illness due to COPD.

The overarching objective of the 'Healthy Kitchen/Healthy Stove' pilot project was to reduce indoor air pollution among indigenous communities in the high Andean region through an integrated and sustainable household energy intervention, with women and children as the primary target, given their traditionally higher exposure to kitchen smoke. This project expands upon a 1-village pilot effort of the Pan-American Health Organization and GTZ to address indoor air pollution, complementing the demonstrated improved stove intervention with behavior change communications and the establishment of community institutions and an innovative finance mechanism to increase the sustainability of the intervention. The USAID intervention targeted households across at least 20 of the 60 communities in the rural district of Inkawasi, in the northern department of Lambayeque, (with 33 ultimately incorporated into the project), aiming to demonstrate a program model for replication elsewhere in Peru and throughout the Andean region. In this district, some 3,000 Quechua-speaking families (roughly 15,000 people) live at 1,600 to 3,200 meters above sea level.

The indigenous population in this high-Andean region is made up largely of subsistence farmers with incomes of less than $1/day. They rely exclusively on biomass for cooking, which is done over 3-stone fires inside small, poorly-ventilated adobe structures, leading to extremely high indoor smoke levels. Houses typically are built of adobe, roads are unpaved, and electricity service is unreliable and reaches only a small portion of the population. Economic and retail transactions mainly rely on bartering with a notable lack of any real cash economy. Prior to the intervention, people knew that smoke was bad for them, but only in that

it made them cough, and their eyes water; they had no awareness of any long-term or specific child health impacts. As with the Bangladesh pilot, this project aimed to develop and demonstrate an integrated energy and health intervention model for future replication and investment on a larger scale.

2.4.2. Approach/Activities

The Peru intervention sought to demonstrate a market-based model, following on the belief that subsidy-based programs are ultimately short-lived and often result in minimal adoption of the introduced technology due in large part to lack of user buy-in. Given the lack of a cash economy, and the fact that families generally do not pay for fuelwood (and therefore cannot repay the stove cost through fuel savings, as could be done in Bangladesh), a key component of this project is an innovative micro-credit system that draws on this population's barter tradition.

View of Inkawasi

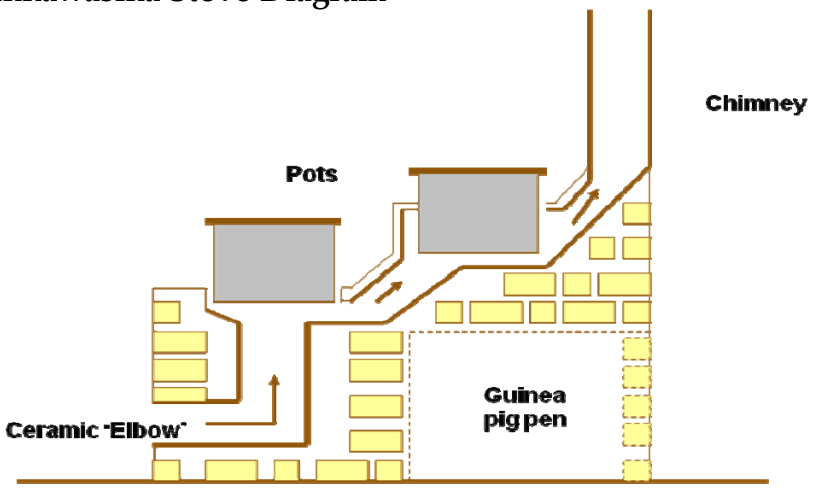
Further, the isolation and corresponding costs of imported goods dictated an approach based on locally-produced, efficient woodstove with a chimney, constructed using local materials to the extent possible.

The Peru intervention integrated 5 core components:

1. **Social organization**. Local organizational infrastructure was developed to promote the intervention and assume management of the micro-loan system. This involved developing a cadre of environmental health promoters; community-level environmental health committees of these promoters; and, in turn, associations of the committees responsible for managing the micro-loan system.
2. **Behavior change communication**. Awareness raising and behavior change communication within the target population and neighboring families about: a) the risks associated with exposure to indoor air pollution; and b) technological and behavioral options to reduce exposure. These messages were transmitted through multiple means and media, including printed materials (murals, posters, flyers, and pictorial images), radio spots, promoter educational sessions at households and with community groups, and healthy kitchen "competitions."
3. **Development of micro-loan mechanism.** To maximize access to the stoves, Winrock and Centro ECO developed an animal-based micro-loan system to reflect the region's reliance on barter to exchange goods and services, based on Centro ECO's success with this type of finance mechanism in other parts of the country. The foundation for a sustainable market was built through both the development of local stove entrepreneurs as well as the establishment of the micro-loan mechanism. This involved training ceramic artisans to make stove "elbow" combustion chambers, and stove builders to assemble the stoves in situ. The micro-loan system comprises loans in the form of a "module" of several animals that borrower households reproduce and repay to cover the original loan, the cost of the stove, including a small fee for services (stove builder, elbow maker, and promoter technical assistance), and interest, to sustain administrative costs associated with the loan system. Installed stove costs total around US$25 plus in-kind materials and labor required of the family.
4. **Stove promotion and dissemination**. A locally developed and tested improved "Inkawasina" woodstove based on high efficiency and low emissions design principles was disseminated across a third of the communities in the Inkawasi district. The stove, developed and tested by local NGO Centro ECO under a GTZ-PAHO pilot project, is generally based on the "Justa" stove model developed in Honduras and utilizing a "Rocket" elbow combustion chamber and other efficient design principles, shown in the diagram below (see also the Annex B for a detailed schematic of the stove). The 2-hole,

sunken-pot model was chosen rather than a solid metal griddle design due to its lower cost. Because this stove had been developed via a highly participatory process with substantial community input under the previous pilot, no further consumer demand characterization was undertaken.

Inkawasina Stove Diagram



5. **Indoor Air Quality Monitoring**. Changes in kitchen concentrations of respirable particulate matter (PM_4) and carbon monoxide (CO) were monitored as part of the intervention, through pre-intervention measurement (48 households) and follow-up at approximately 12 months (42 households) and 24 months (32 households).

Inkawasi family with improved stove

Additional complementary activities were undertaken to further the learning about the impacts of this intervention. These included household energy practices and perceptions surveying across the district, and fuel wood monitoring and lung function monitoring, each among small samples.

Winrock worked with the local NGO Centro ECO, based in the Northern department of Lambayeque, in the planning of field implementation activities, which Centro ECO also led. Winrock hired the Lima-based office of the international agency Swisscontact to conduct the indoor air pollution monitoring, given its experience with ambient air pollution monitoring in Peru. The health symptom monitoring was conducted by U.S.-based volunteer physician Dr. Jay Smith.

2.4.3. Results

This project attained a significant number of its goals, and surpassed several of them. The project achieved its primary objective to significantly reduce indoor air pollution among the target households of the Inkawasi district: after 12 months, PM_4 and CO kitchen concentrations dropped by more than 70% on average in the sample of 42 households. In 30 of the homes, IAP levels dropped by an average of 84%. In the remaining 12 households, the IAP levels either didn't change or (surprisingly) increased; follow-up with these households revealed

both outlier structural contributors as well as a few behavioral factors which project promoters have noted and are working to correct. Follow-up monitoring in 2007 (24 months post-installation) showed average decreases of 64% among half of the 32 homes, with no change or increased IAP in remaining homes, the primary causes of which were identified as quality control of stove components and cooks' fuel management practices.

Another significant result is the creation of jobs for 27 entrepreneurial promoters; 21 are now trained as stove builders, and 6 are making the ceramic combustion chamber "elbows" for the stoves. All are paid a fee for their work, derived from the revolving loan fund as animals are sold by the fund managers and converted to cash. In addition, the promoters themselves, while primarily working on a volunteer basis, are paid a modest fee for follow-up technical and veterinary assistance to borrower families.

Messages about healthy kitchens have also been passed to children, who are the main beneficiaries of the new behaviors and practices.

As of August 2007, the stove builders had installed a total of 377 stoves, or approximately 60% of the 600-household target, with additional installations eventually surpassing 700 stoves detailed below. This sub-target result within the project period is due largely to a mid-implementation decision by USAID and Winrock to shift emphasis from rapid stove dissemination to strengthening local skills in management of the micro-loan system. The change in course sought to address the fact that most promoters did not have well-developed accounting skills or experience with proper care of chickens, guinea pigs and ducks,

which were used as the loan currency. The project team believed that ultimately, a well-functioning loan system would be a better enabler—and predictor—of a sustainable market than a higher number of installed stoves in the project period.

Peru Results Summary

Indicator	Result
Percent of homes that experienced a decrease in IAP at the 12-month follow-up visit (30 of 42 homes)	**71%**
Average reduction in PM_4 at the 12-month follow-up visit for those 30 homes with reductions	**84%**
Average reduction in PM_4 at the 12-month follow-up visit for all 42 homes	**70%**
Percent of homes that experienced a decrease in IAP at the 24-month follow-up visit (16 of 32 homes)	**50%**
Average reduction in PM_4 at the 24-month follow-up visit for those 16 homes with reductions	**64%**
Average reduction in PM_4 at the 24-month follow-up visit for all 32 homes	**-10% (increase)*** **
Number of stove-related jobs created*	**27**
Inkawasina stoves purchased*	**377**
Animal modules** loaned*	**491**

** Results as of August 2007*
***Usually one male and five female chickens, or one male and ten female guinea pigs*
**** The primary cause of increased IAP at the 24-month follow-up in some homes was identified to be disabled stoves, due to construction flaws and stove misuse.*

A number of indications have suggested that dissemination will continue at a healthy pace beyond official project closure. More than 60% of the value of the loans made by then had been recovered, despite setbacks due to slow reproduction rates and higher-than-expected animal mortality. The fuelwood monitoring revealed that consumers are using 32% less fuelwood with the Inkawasina stove; focus groups suggest that the perceived savings are even

Beneficiary testimonial: *My new baby does not tolerate being around a smoky kitchen, as she was born after my new Inkawasina stove was installed. She cries out loudly when there is smoke in the kitchen," says Silvia Aurora Carlos de la Cruz, beneficiary of the in Healthy Kitchen/Healthy Stove pilot project in Uyurpampa, Peru.*

greater. Further, the surveys, focus groups, and anecdotal feedback suggest that a large majority of households in the district now understand that IAP poses serious health risks and are aware of measures they can take to reduce those risks.

Households overwhelmingly cite indoor smoke elimination as their top motivation for stove adoption. Time savings and cost savings are next on this list, with a fourth motivation of improved stoves being "good for the environment" also frequently cited.

The health symptom monitoring, though not conclusive due to a small sample size, suggests there was a slowing in the typical age-related decrease in lung function among household members where the improved stoves resulted in large decreases in indoor particulate concentrations. Survey results show that many people felt their health had improved. Overall, consumers appear to be very pleased with their stoves, are aware of multiple benefits and are complying with loan repayments, albeit more slowly than anticipated.

Gender roles impact participation:
Although Winrock aimed to involve as many women as possible at all levels, local customs and gender roles in Peru combined with the physical demands and the time commitment away from home made the work of building stoves and constructing ceramic elbows less attractive and viable options for women.

Finally, an unexpected result was the direct purchase of the Inkawasina stove by 35 families. This suggests that the IAP messages and advantages of the Inkawasina stove are spreading beyond the target population to an unexpected segment that both values the benefits and has the capacity to pay without the assistance of a loan. With these results, Winrock expects that this IAP reduction model developed in Inkawasi can be replicated elsewhere in the region and scaled up, provided the lessons learned are taken into account.

Since the close of the project implementation period in September 2007, the activities initiated in Inkawasi have continued and even picked up speed, with both increased stove demand, and increased promoter and manufacturer capacity to meet the demand, without external funding. By September 2007, about 380 improved stoves had been purchased and installed and more than 400 animal modules had been distributed on loan. By March 2008, the Environmental Health Associations had supported the adoption of about 700 improved stoves, and loans of

more than 800 animal modules. This continued success demonstrates the sustainability of the project, which relied on local organizations, developers, and community leaders influencing their neighbors and friends about the importance and benefits of the improved stoves.

2.4.4. Conclusions

Among the key factors contributing to the project's success in raising awareness and interest in adopting improved stoves and new behaviors is the commitment of the community promoters and the level of community organization that ECO was able to facilitate within the first year. A structure of community-level Environmental Health Committees and three geographically-grouped Associations of those committees created both visibility for the project, and a means for transmitting the core messages, sharing feedback, and generating camaraderie as well as accountability for the results. The project reached 33 (over half) of the district's communities and trained 60 men and women promoters, plus 21 stove makers (men), 6 ceramic combustion elbow makers (men), and 35 women were trained in the construction and use of retained heat cookers. Although Winrock aimed to involve as many women as possible at all levels, the physical demands and the time commitment away from home made the work of building stoves and constructing ceramic elbows less viable options for women, given local customs and gender roles.

A promoter points to illustrations on the kitchen wall of a beneficiary household depicting proper stove operation and maintenance.

Survey results and focus group feedback suggests that the community promoters were more effective at raising awareness and motivating people to adopt the stoves and behaviors than the other media employed, including radio spots, informative murals, posters, and flyers. In household visits and larger discussions with women's groups and other community gatherings, the promoters used a variety of techniques for

communicating the project's messages, including pictorial materials developed under the project by an artist and communications specialist, and field tested for effectiveness in conveying messages about smoke in the kitchen and the benefits and proper use of an improved stove. Consumer households were given copies of these materials to post on their walls to reinforce the messages.

The radio spots were loosely based on the short-format (30-second) dialogues used in Kenya; each of 3 spots was run 3 times a day between 6-7pm for three months in Spanish and Quechua. The radio messages spread initial information about the project quickly. The spots appeared to have been particularly useful in prompting several leaders of communities reached by the radio messages to approach the EHAs and ask to join the project and form EHCs. However, the post-intervention survey conducted by Centro ECO suggested that the radio spots were less influential than direct visits by promoters in raising awareness among typical households about the project and its messages, perhaps due to their limited broadcast time. Future radio campaigns should be run for at least six months, and in the local language (Quechua, in this case) for maximum impact.

Competition fosters enthusiasm and engagement: *"Healthy Kitchen Competitions" in Peru proved to be very successful at inspiring creative approaches to kitchen organization and hygiene; several families constructed new kitchens in anticipation of the new stove.*

Several promoters have since requested that the spots be continued; however, budget is no longer available for this. The flyers, posters and murals include images of stoves, healthy women and children, and photographs of the stove builders for easy recognition; however, the Spanish and Quechua text is not accessible for a large portion of the population that is illiterate, especially women. Thus, the promoter outreach, either through individual household visits or to groups of women or mixed groups is logically more effective than print media. A series of "Healthy Kitchen Competitions" proved to be very successful at inspiring creative approaches to kitchen organization and hygiene; several families even constructed new kitchens, often with increased size and ventilation, in anticipation of the new stove.

This intervention model's heavy reliance on largely volunteer community promoters for product promotion and transmittal of the core health and behavior messages could hamper replication efforts due

to the high promoter-to-consumer ratio and the implicit investment required for ongoing training as coverage expands into new territory. This is a real consideration; the costs (in resources and time) of building an effective cadre of promoters must be weighed against the effectiveness of person-to-person promotion over other means. Winrock believes that efficiencies can be gained through a well-planned and formalized training program, combined with a more comprehensive and longer-term radio broadcast program including more in-depth coverage than the 30-second spots allow.

Additional details on the Peru pilot intervention activities and results can be found in the referenced Peru Pilot Report.

3. Key Challenges and Lessons Learned

The integrated energy and health intervention models implemented in Bangladesh and Peru resulted in significant reductions in indoor air pollution in the majority of households participating in the projects. Equally important is the evidence that suggests that households in both project areas have, by and large, accepted and adopted the improved technologies promoted through locally-developed entrepreneurs and networks of trained environmental health volunteers. Foundations have been laid for sustainable market systems to continue dissemination of the knowledge and technologies, including entrepreneurs in stove building and micro-credit systems appropriate to the cultures and project areas. The local NGO partners and trained promoters have gained experience with troubleshooting and evaluating stove performance, as well as with communicating the project's core messages on health risks of smoke and measures to mitigate the risks.

The Winrock team is thus generally pleased with the overall results of these integrated models, and believes that each has the potential to be replicated. At the same time, both pilot interventions faced challenges that should be identified in order for future replication to avoid similar pitfalls and ultimately yield even greater results. This section outlines some of the primary challenges encountered in Peru and Bangladesh, and articulates lessons for consideration in replicating these models.

3.1. Project Management

Selecting the right local partners to lead an intervention is crucial, and yet finding a single organization that "can do it all" is near impossible, particularly given the multi-faceted nature of these integrated models. Though local NGOs can be the most appropriate choice for their experience working with local populations, they are often limited in capacity and breadth. It is very important to identify each partner's limitations from the outset, and to adjust the task responsibilities to reflect staff and organizational capabilities, and require or provide external support for tasks or activities that go beyond the organizations' current capabilities to efficiently and effectively address within a given timeframe.

In Peru, the selection of Centro ECO was logical due to its participation in the predecessor pilot, its experience with the promoted technology, and its lead staff with direct connection to the region. In Bangladesh, the selection of VERC and Concern Worldwide Bangladesh was also logical, given VERC's regionally-recognized expertise with improved cookstoves and its experience with the MPA tools, on the one hand, and Concern's extensive health networks, experience with behavior change communications, and national presence, on the other. These were solid choices for partners, and the projects both nonetheless had capacity challenges due to the number and type of tasks required within a 2-year period.

Key Challenges

- **Staff overextension**: Local partner staff can quickly become overextended by intense program activities and schedules. Centro ECO and VERC had a small number of technical staff, who quickly became stretched with the number of simultaneous activities programmed in the implementation plan. Though both of these organizations participated in the planning process, and often recommended one or more activities, neither organization fully anticipated the extent of overload for their staff. In addition, both organizations were reliant on one or two key individuals with core skills; losing these staff resulted in a loss in leadership and expertise which was not easily replaced.
- **Business skill capacity**: Many NGOs do not have strong business skills. Though Centro ECO has very strong accounting skills, for example, additional business skills would have eased the development and management of the micro-loan system.
- **Survey and data analysis capacity**: Many NGOs do not have formal survey and data analysis capabilities, which are critical to conducting baseline assessments. Under these pilots, the implementing partners were tasked with baseline and follow-up household monitoring both because of budget limitations and because having fewer actors seemed simpler. The partners were familiar with the project area and thus access into the homes was made easier than if an unknown group were to administer the surveys. However, the monitoring task tended to detract from—and delay—implementation work, and further, it was made more vulnerable to bias.
- **Partner coordination**: Many projects rely on working with teams of partners. In Bangladesh, working with two primary implementers (one on the health side, the other on the energy and community-organization side) led to more complex coordination and some tension due to the

distinct organizational interests and cultures. This was difficult to navigate, particularly from afar.

Lessons learned

In the event that an implementing partner is not strong in one or more key areas, it is likely more cost-effective to provide a specialist rather than burden the lead implementer with tasks that are outside their comfort zone, and thus, will take extra time, distract from core activities, and may yield a mediocre product. For example, a university or private-sector research team could likely produce a more sound household energy practices and perceptions assessment in a shorter timeframe and potentially at lower cost than a local implementer not trained in this area. Similarly, hiring a specialist to conduct business skills training could be a cost-effective approach, in the absence of a partner candidate with strong enterprise-building experience. In addition to strong business skills, core capabilities to seek in a partner (or at least covered by a contracted specialist) include strong community organizing experience and improved stove-specific technical skills. The involvement of a key staff person with both direct experience with the improved stove being promoted and a personal connection to the target communities is especially desirable.

In addition to implementing partner and specialist support, Winrock recommends that close attention be paid to sequencing of activities and planned timeframes. Activities in both pilots, as well as in Kenya, were complicated by one element of implementation taking longer than expected, and thereby detrimentally impacting other activities. In addition to just making other activities run later, such delays -- combined with a tight timeline -- can preclude elements of implementation due to limitations posed by rainy seasons, for example. Whether or not activities run late, some remote communities are only occasionally accessible, even for partner NGOs, dependent on weather conditions. Implementers should build in additional float time to adequately accommodate unexpected delays. Winrock also recommends an in-country project manager, which can greatly facilitate relationships and communications. This is especially important when working with more than one implementing organization.

3.2. Improved hardware and fuels

The Peru and Bangladesh pilots differed significantly in this component. In Peru, the improved stove promoted by the project had already been developed, lab tested and field trialed by a previous project. While slight modifications were made under the USAID project, and training was required

to develop knowledgeable promoters and skilled stove builders, the stove design was determined and ready for introduction from the start of the project. Moreover, this stove was introduced to an area with little to no exposure to any form of improved stoves, with the majority of households still relying on open fires.

In contrast, no single stove model had been adequately tested and field trialed in Bangladesh. Thus a core task was to test and select one or more appropriate models for promotion under this intervention. Because the target population already used rudimentary stoves to contain the cooking fire, additional considerations about stove performance and preferences contributed to the stove selection process.

Challenges

- **Quality control** and **Meeting needs**: In Peru, two main challenges were encountered:

  1) The ceramic elbow combustion chambers experienced cracking or, in some cases, collapse. While it appears that the majority of failures can be traced back to one elbow-maker, the problems highlight the vulnerability of the design to poor production methods, and further, can cause more extensive negative perceptions than the actual number of failed elbows. There is some evidence that breakage has been exacerbated in households where the cook has not adopted good fuel preparation and management practices—i.e., still uses large pieces of wood, which, when forced into the stove can put unnecessary stress on the elbows. A few bad elbows can damage a reputation of a supplier as well as the program.

  2) Families tend to have several pot and kettle sizes, which can lead to leakage when using a pot that is smaller than the stove hole. The stove promoted under this intervention accommodates only two hole sizes, while most families have more than 2 sizes of pots.

- **Technology selection**: In Bangladesh, the main challenge was not having a stove selected from the beginning. This caused delays in the social marketing and other aspects of the stove commercialization process. The team underestimated the complexity and time requirement for stove selection, a process that was further delayed by monsoon rains and political instability.

Lessons

For future interventions, Winrock recommends that projects in which an appropriate technology has yet to be identified should first and foremost map

out the selection process thoroughly, based on local cooking practices and stakeholder input. The technology options must be identified or developed during the baseline stage, before the promotion phase begins. Other tasks such as awareness-raising, social mobilization and entrepreneur development should only proceed once the technology choices have been selected. Once the technology choices are identified, attention must then be paid to quality stove components. For stoves incorporating a combustion elbow, which is a critical component, extra effort should be dedicated to sourcing appropriate clay, using the best possible "recipe" for resilience, and verifying the production methods of each trained artisan. Where gaps exist between small pots and larger holes, a simple metal adjustment plate can be crafted in the field out of commonly-available tin cans, flattened with a hole cut in the middle; this practice should be incorporated into the toolkit of project problem-solving. Finally, attention should be paid by stove promoters to proper fuel preparation, emphasizing not only the benefits of less fuel consumption by using smaller pieces, but also the dire consequences of forcing large pieces into a breakable combustion chamber.

3.3. Promotion of effective behaviors

The core messages of the Peru and Bangladesh interventions were very similar; however, the approach to developing and communicating these messages differed in some basic ways. The most obvious difference was in the use of the Methodology for Participatory Assessment (MPA) in Bangladesh for raising awareness, developing messages, identifying stove preferences, and generally engaging the community in the decision-making processes that would govern the promotion and dissemination of the improved technologies and practices. This tool has been lauded in the water and sanitation sector for its effectiveness in securing community buy-in and identifying factors for success. There have been a handful of attempts to adapt the MPA's numerous tools to the energy sector, including a recently completed and field-trialed adaptation by ARECOP for use in household energy projects, particularly in Southern and Southeast Asia. As Winrock learned, the MPA was very effective in engaging and organizing the community. At the same time, it was complex and time-consuming, and Winrock would recommend using only a subset of the MPA tools in future interventions, with the specific tools to be determined by the needs and goals of each given intervention.

Overall, perhaps the greatest similarity in approach between the interventions was the mix of media and vehicles for transmitting the core messages. This mix appears to have been very effective in reaching a broad audience. While the short timeframe of the communications campaigns prevents verifiable conclusions about the relative effectiveness of the various messages and media,

some general observations can be made and lessons drawn from these experiences.

Challenges

- **Activity sequencing**: In Bangladesh, the plan was to link the behavior change messaging with social marketing messages; however, the delays in selecting appropriate stove models caused a disconnect between the efforts to raise awareness of IAP and those designed to mobilize the adoption of improved stoves. In Peru, direct promotion through promoter household and community-group visits was initiated before the pictorial materials were finalized. The materials aimed to convey messages about indoor smoke and sick children, in contrast to a clean and orderly kitchen with an improved stove and healthy, happy faces, as well as proper operation and maintenance of the improved stove. Promoters who were not initially equipped with these materials were handicapped, and may have been less effective in conveying behavior change messages. Some households have been much less effective at operating their stoves effectively than most; it is possible that the lack of pictorial materials during the first installations played a role.
- **Staff overextension**: In both interventions, the implementers were stretched too thin in the awareness and promotion activities; in Bangladesh the stretch was largely due to the number of activities involved, and in Peru the overextension was more due to the ultimate breadth of geographic coverage that the promoters targeted (due to continual requests from neighboring communities to join the project, and over enthusiasm on the part of promoters and implementers in granting additional inclusions) within a relatively short period of time. In cases, the focus and effectiveness of the messages was compromised.

Lessons

Winrock's experience showed that too many social mobilization activities can overload the partners and complicate implementation. For future interventions Winrock recommends that resources be optimized by consolidating presence in a manageable number of villages and achieving a sustainable administration system before attempting to reach out to additional communities. Messages, whether written, spoken or relayed through pictures, should be developed through participatory process such as focus groups and using MPA tools. Rather than applying all MPA tools, a small number should be selected as appropriate, based on the specific needs and goals of individual interventions. Stoves need to have been identified, and better still, demonstrated when assessing consumer choice preferences, whether through the MPA or other methods, so as to be able to incorporate all factors, including

cost. When used in conjunction with identification of improved stoves and an effective marketing plan, the MPA is an effective way to both gather data and kick start stove adoption through increasing awareness and demand.

A mix of media is effective to address a broad range of audiences. Printed materials (e.g. posters, murals, leaflets) appear to be less effective and should be accompanied by activities involving direct engagement, such as promoter visits to households and community groups; film shows and folk song performances; road shows with demonstrations; extended radio programs; and healthy kitchen competitions. Radio broadcasts should include both spots and lengthier programs, as was done in Kenya, and should be aired for several months, as campaigns of only a month are unlikely to have significant impact.

Person to person contact counts: *Direct personal contact, via community promoters, road shows and demonstrations, films and folk song performances, was consistently more effective at raising awareness and motivating people to adopt stoves and behaviors than printed materials.*

Though many of the aforementioned activities require more investment in time, transportation, and personnel resources than distribution of printed material, payoff is likely to come in the form of greater internalization of the messages and adoption of improved practices.

3.4. Improving the enabling environment

With both interventions committed to building sustainable markets for improved woodstoves, Winrock focused most intently on building effective community-based organizational infrastructure, empowering local entrepreneurs, and increasing access to improved stoves through appropriate micro-finance. At the same time, Winrock and local partners sought numerous opportunities to engage local policy-makers and other stakeholders prior to and throughout implementation.

On the whole, the projects were very successful at engaging men and women in community-level discussion on indoor smoke, and ultimately creating community-led committees and other structures to promote improved stoves and behaviors and manage dissemination activities. The pilots were also successful at achieving the dissemination of hundreds of improved stoves, each either through direct sales or with micro-loans, and thus demonstrated that even among very poor communities a commercial approach could be

utilized to avoid reliance on subsidies. Each project did, however, encounter challenges to building a robust market system with skilled entrepreneurs.

Challenges

- **Commercial approach**: In Bangladesh, the subsidy mentality was difficult to dismantle, even among project implementers. Both VERC and Concern were accustomed to subsidized activities and initially saw the commercialization process as an imposition on the poor households. The fact that the implementers themselves were not convinced of the need and appropriateness of a commercially-oriented intervention led to miscommunication with promoters and, in turn, households about the project's approach. In Peru, Centro ECO also had the general impression that the indigenous people of the high Andes, who rely on barter to exchange goods, were too poor to participate in a market-based system.
- **Beneficiary capacity**: The low literacy rates, and lack of formal business experience in general, in both project areas hindered the process of developing both the entrepreneurs and the community-level committees responsible for product promotion and, in the case of Peru, micro-loan management.
- **Quality control**: Quality control was a challenge in both interventions. In Peru, quality issues were largely centered on the combustion chamber elbows, although the problems were not consistent across all producers, suggesting that while most of the artisans may be following good production processes, one or more artisans may be cutting corners or otherwise failing to follow best practices.
- **Volunteer attrition**: In both Peru and Bangladesh, the (environmental health or health) promoters work on a largely volunteer basis. While this appears to be a common situation in both countries, a voluntary system is more likely to suffer drop-out than a system in which promoters receive some incentive for their services.

Lessons

Winrock considers it crucial that a market-based focus be made clear to the project partners, and subsequently to the broader community, from the very beginning of any project, including a thorough discussion of *why* this approach is important. Examples of failed improved stoves programs may help underscore the pitfalls of subsidized programs. The MPA process can be simplified to focus on entrepreneurs, and can be more effectively used to link entrepreneurs with target households by raising awareness on the services and products available through the entrepreneurs. Finally, the field-based implementation/promotional schedule should proceed based on sound and locally accepted technology options. The evaluation and selection of

appropriate technologies can take time, and delay implementation schedules, as shown in the Bangladesh pilot. Generic promotion activities not tied to specific models are less effective; the more concrete the discussions of stove cost and pricing, the more quickly the commercial concept can take hold.

The selection of target population will determine the extent to which business experience exists among local leaders and the broader population. Clearly, where small businesses already thrive, a more solid foundation of experience exists and in turn can lead to more rapid development of stove entrepreneurs and micro-finance systems and management. For less sophisticated populations, on the other hand, a carefully-constructed training plan should be implemented that covers basic principles upfront, and includes periodic refresher trainings and review of fund management. This training for project promoters and entrepreneurs, as appropriate, should be sequenced such that the first stage precedes product marketing and the identification of the first round of loan recipients/beneficiary households.

Motivations for stove adoption vary: *In Peru households overwhelmingly cite indoor smoke elimination as their top motivation for stove adoption; in Bangladesh the primary motivator was cost savings from reduced fuel needs; Kenya consumers consistently ranked maintenance costs, fuel costs, and especially initial investment cost, as the strongest driver behind cooking device purchasing decisions.*

To avoid the most obvious quality pitfalls, robust product testing should ideally take place at the very beginning of the project. However, a program model based on developing small entrepreneurs through the course of dissemination expansion implies that variations in stove production are likely to occur over time. Thus, a quality control program should accompany entrepreneur development, including a review of the stove builders' materials and production processes. This will require a trained stove expert either within one of the local NGO partners or among the community promoters themselves. Quality control should include a troubleshooting process with periodic household visits and user feedback. A product guarantee should be considered, at least among the first round of stove recipients, to avoid early abandonment in the event of stove failure.

Some promoter turnover is natural and should be expected, especially when the job is largely voluntary. A minimal service fee for project promoters can go a long way to motivate continuation with the project. Other non-monetary incentives that visibly associate the promoters with the project, such as shirts, caps and satchels, can create an important sense of status and pride that further

motivate promoters. In the end, if the product works and is valued by the community, the most entrepreneurial promoters will be the ones who find ways to continue promoting the product and benefiting from the demand.

4. Conclusions and Recommendations

The objective of this work was to support sustained adoption of improved energy technologies and practices to improve indoor air quality for the urban and rural poor, and thereby reduce associated health impacts for those most at-risk, especially young children and women. The program goal in support of this objective was to develop and demonstrate models for sustainable improvement of indoor air quality through fuel, stove or housing improvements, coupled with behavior interventions.

The integrated energy and health intervention models implemented in Bangladesh and Peru were successful in achieving sustained technology adoption and significant reductions in indoor air pollution, including through improved behaviors. Even more importantly, they succeeded in establishing ongoing non-subsidized locally-developed improved stove markets in two very different geographic, cultural and socio-economic settings.

With effective models established and important lessons learned along the way in program design, implementation and evaluation that will serve to inform future activities, the next step is to replicate and scale-up the models beyond the initial pilot demonstration stage.

Building on lessons learned under the program detailed here, follow-up initiatives should ensure programs incorporate specialists to guide and complement local implementer capacity; carefully monitor the sequence and timeline of implementation activities (see example shown here); and utilize an in-country project manager. Projects should also closely monitor quality control of stove components, and crucial communications with users on stove maintenance and fuel preparation. A sound, robust and tested product that is easy to use and maintain will reduce failure rates and costs associated with behavior change communications.

Project Implementation Check-list	
Phase 1	☐ Secure local government cooperation/support ☐ Capacity building of project staff as needed [including microcredit staff if applicable] ☐ Hire any needed specialists to complement local implementer capacity ☐ Promote project with beneficiary groups ☐ Baseline assessments, including surveys, focus groups and IAP monitoring ☐ Based on needs identified above, identify desired stove characteristics ☐ Stove identification, enhancement and/or development ☐ Stove testing and selection ☐ Development of behavior change and social marketing messages ☐ Capacity building of community to manage project components ☐ Identify/select stove builders/entrepreneurs, promoters ☐ Capacity building of stove builders/entrepreneurs (and seed fund disbursement if applicable), and promoters ☐ Promotion of project with local government (ongoing)
Phase 2	☐ Behavior change communications and social marketing, including films, radio spots, demos, health promoter visits ☐ Stove installations ☐ Training of beneficiaries in kitchen management and stove use and maintenance ☐ Refresher trainings of entrepreneurs, promoters and/or users, as needed ☐ Mid-implementation stove performance testing, adjustments to stove designs as needed based on testing results and user feedback
Phase 3	☐ End of project assessments, including surveys, focus groups, and stove performance and IAP monitoring ☐ Final workshop/other local results dissemination

Social mobilization activities should be carefully planned to prevent overextension, and messages, whether written, spoken or relayed through pictures, should be developed through participatory process, and relayed through a mix of media (including printed materials, direct engagement; films and musical performances; road shows and demonstrations; radio programs) to address a broad range of audiences. The messages themselves, of course, must reflect priorities of the target audience, which can vary tremendously. In Peru, for example, households overwhelmingly cite indoor smoke elimination as their top motivation for stove adoption, with time savings and cost savings as runners-up; in Bangladesh the primary motivator was cost savings from reduced fuel needs, with IAP reduction and health a close second. In Kenya consumers consistently ranked maintenance costs, fuel costs, and especially initial investment cost, as the strongest driver behind cooking device purchasing decisions, with health considerations nowhere near the top of the list. Programs should use a strong promoter network when possible, using volunteers where appropriate and cost-

effective, given training requirements and attrition tendencies, and when an engaged and invested volunteer coordinator is available.

To best improve the enabling environment, programs should focus on building effective community-based organizational infrastructure, and empowering local entrepreneurs including those in related (e.g. water/sanitation) sectors whose skills and raw materials may provide convenient overlap. The success of the programs in Bangladesh and Peru depended on working with existing local government institutions and health networks and promoters in Bangladesh and community-level Environmental Health Committees and geographically-grouped Associations in Peru. Programs should also work to increase access to improved stoves through locally-managed micro-finance options appropriate for target populations. In some cases, innovative non-case options, like the animal husbandry system implemented in Peru, may be the most effective solution. The community based organizations in both countries created visibility for the projects, supported project messages, and in Peru managed the micro-loan system. Finally, programs should incorporate engaging local policy-makers and other stakeholders prior to and throughout implementation. Having this level of awareness and community leader ownership of project activities can make community mobilization more effective and support the quick resolution of project implementation challenges.

Finally, regular monitoring of project results during and beyond the formal project implementation timeline is crucial. To best ensure success, programs need to allocate resources to provide refresher trainings, track quality control and technology design issues, and quickly address additional complications that arise mid-course, as well as those that surface following official project closure and threaten to derail achievements and progress made during implementation.

ANNEX A: Winrock Pilot Project Fact Sheets

(fact sheets on following pages were updated May 2009)

Reduction of Exposure to Indoor Air Pollution through Household Energy and Behavioral Improvements in Bangladesh

Background: Over two billion people in the developing world use biomass for heating and cooking over open fires or with rudimentary stoves. The World Health Organization estimates that exposure to smoke from these stoves causes an estimated 1.5 million premature deaths each year, particularly among women and children.

In Bangladesh, acute respiratory infections (ARI) are one of the leading causes of under-5 deaths. The country has one of the highest under-5 mortality rates in the world with about 900 deaths/day and 325,000 every year. About 94% of the energy to meet cooking needs comes from biomass sources.

Cooking smoke emitting from a Saidpur home

Development Objective: The main objective of the USAID program implemented by Winrock International was to develop a replicable and scalable program models that address indoor air pollution through an integrated approach involving lessons and expertise from both the health and energy sectors. To demonstrate the efficacy of this approach, Winrock implemented pilot projects in Peru and Bangladesh between 2005 and 2007.

Bangladesh Project: The overall goal of the pilot project in Bangladesh was to develop and demonstrate a household energy intervention model that integrates health and energy aspects, and leads to alleviation of indoor air pollution and improved energy efficiency. The objective of the pilot project was to reduce indoor air pollution and fuel consumption via the dissemination and commercialization of improved cookstoves among peri-urban communities through an integrated and sustainable household energy intervention. The project aimed to establish a sustainable market for improved and appropriate stoves to avoid the need for subsidies. Awareness raising activities through behavior change communication and social marketing were key components of this project.

The project supported the adoption of improved technologies and practices in slum households that cook predominantly with biomass fuels and are situated in extremely congested settings in two urban municipalities, Saidpur and Parbatipur, in the North-West of Bangladesh. The vast majority of these households earn between US$1-2 per day, and spend about 10-20% of their income on low quality fuels such as rice husk briquettes, wood and cow dung. Families cook with traditional stoves that are typically made of mud and not energy efficient. The combination of low quality fuels and inefficient stoves results in high levels of emissions during stove use with pollution levels be exacerbated by the close proximity of households in these areas. Given the restricted cooking spaces, rudimentary house construction, and close proximity to neighbors a highly-efficient, low-emission portable stove with no chimney was the most feasible and appropriate technology option.

Partners: Winrock worked with two main partners in this pilot: Concern Worldwide, Bangladesh and Village Education Resource Center (VERC), two grassroots level NGOs, with experience with behavior change communication in health and participatory implementation of improved cookstove programs, respectively. Concern had worked in Saidpur and Parbatipur for over 30 years and helped establish Ward

Health Committees in these cities under a still ongoing USAID child survival activity. In partnership with Winrock, Concern led the behavior change activities under this project. VERC is a local NGO with experience in community-based development, dissemination of improved stoves (a focal point for the Asia Regional Cookstove Program: ARECOP), and a partner organization during the Government of Bangladesh-funded improved stove program in the 1980s. In addition Winrock collaborated with Dr. Alauddin of Wagner College, New York for indoor air pollution monitoring and sample analysis.

The project utilized participatory tools to ensure the participation of the affected communities, and engaged government agencies, including local health committees, in the tasks of information dissemination and awareness-raising. Local entrepreneurs, including women, were trained on enterprise and business development and encouraged to launch stove businesses through micro credit support. An advisory committee consisting of relevant donor, NGO and government representatives has been formed to provide guidance to the development of the project.

Three models of improved cookstoves, each significantly less polluting than traditional stoves, were selected and promoted in this project. All the improved stoves showed a significant reduction in particulate matter, ranging from 39% to 84% per stove, and 65%- 99% reduction in carbon monoxide when compared to the traditional stove in an average 48-hour indoor air quality monitoring of kitchens. Savings on fuel cost for households who purchase their cooking fuels resulted in a payback period of as low as 2-4 months, depending on the type of improved cookstove purchased.

Through an emphasis on commercialization, the Bangladesh project supported 25 entrepreneurs, out of which 20 have taken loans from the seed funds. As of the September, 2007, a total of 583 improved stoves were sold under the commercialization activity. The entrepreneurs have continued to sell increasing numbers of improved stoves beyond project closure in May 2007, showing strong promise for sustainable stove sales moving forward. Users interviewed during the monitoring visits have reported they are happy with their stoves, and that the cookstoves are saving time and producing little or no smoke.

Winrock coupled product promotion with a multi-faceted communication campaign to raise awareness about the risks of indoor smoke and the benefits of behavior change and using improved stoves to reduce IAP exposure. The project team worked with existing local government institutions and health networks to disseminate behavior change messages, which addressed ventilation, child care in the cooking area, proper fuel management, and cleanliness and hygiene in the cooking area. These messages were depicted in pictorial formats which were then printed on posters to address low literacy rates. About 200-300 posters were disseminated among local health clinics, health practitioners, local government institutions, health volunteers, and households. Concern developed a hugely popular folk song which incorporated these messages, which was performed at 29 folk song sessions. IAP-related awareness-raising messages were ultimately disseminated to over 50,000 people. The project also conducted 216 courtyard meetings, education sessions, and film shows which were invaluable in awareness raising, demand creation and community mobilization.

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Reducing Exposure to Indoor Air Pollution through Household Energy and Behavior Changes in the High Andes District of Inkawasi, Peru

A new improved woodstove (more fuel efficient, cleaner combustion and vented) in an indigenous family home in Inkawasi

Background: Over two billion people in the developing world use biomass for heating and cooking over open fires or with rudimentary stoves. The World Health Organization estimates that exposure to smoke from these stoves causes an estimated 1.5 million premature deaths each year, particularly among women and children.

In Peru, roughly 8 million people, or 30% of the population, live in impoverished rural areas, where they depend almost exclusively on fuelwood, agricultural residue and dung for cooking. In 2000, acute respiratory infections (ARI), which are closely associated with exposure to smoke, were the leading cause of death nation-wide. For the indigenous population, death rates for children under 5, who are most susceptible to ARI, are as high as 100 per 1000 live births, well over twice the national average. Evidence exists that chronic obstructive pulmonary disease (COPD) among women is also a significant problem within this population.

Development Objective: The main objective of the USAID program implemented by Winrock International was to develop a replicable and scalable program models that address indoor air pollution through an integrated approach involving lessons and expertise from both the health and energy sectors. To demonstrate the efficacy of this approach, Winrock implemented pilot projects in Peru and Bangladesh between 2005 and 2007.

Peru Project: The overall goal of the project in Peru was to develop and demonstrate a household energy intervention that drastically reduced indoor air pollution in a typical high-Andean district through access to improved technologies and information on healthy practices. In addition, the intervention aimed to significantly increase the efficiency of fuelwood consumption and reduce time and labor burdens on women and children. It also aimed to establish a sustainable market for improved and appropriate stoves to avoid the need for subsidies, and ensure that stoves would be available to the villagers beyond the project period.

The district of Inkawasi consists of approximately 3,300 indigenous families living in 60 remote villages located some 2000 to 3600 meters above sea level. The population is made up largely of subsistence farmers with incomes less than $1/day. Due to low temperatures and strong winds in the region, kitchens typically have minimal or no ventilation, and cooking is most commonly done over three-stone fires, leading to extremely high indoor smoke levels. The project expanded in both scope and geographic area a project undertaken in 2003 in the community of Ayamachay, Inkawasi, where PAHO and GTZ collaborated to introduce improved stoves in conjunction with water and sanitation interventions. The "Inkwasina" stoves used in both projects are fixed, adobe stoves with two sunken pots and a chimney, employing "Rocket" stove design principles and generally modeled after the Central American "Justa" stove. The project involved 33 of the 60 communities in the district.

Partners: Winrock's primary partner in implementation was Centro de Ecología y Género (Centro ECO), a Lambayeque-based NGO that helped to develop and test the stove introduced in Ayamachay. Winrock worked with Centro ECO to develop micro-entrepreneurs in stove making, together with a locally-appropriate micro-credit scheme based on animal husbandry, to increase the project's potential for sustainability and replication. These intervention components were coupled with awareness-raising on the health impacts of indoor air pollution, and behavior change communications. Centro ECO monitored household energy practices, fuelwood consumption, and women's perceptions of the impacts of the intervention on their health and the wellbeing of their families. Winrock worked with Lima-based Swisscontact to monitor changes in pollutant concentrations resulting from the intervention, through pre- and post- intervention monitoring of indoor concentrations of carbon monoxide (CO) and respirable particulate matter (PM_4). Adult lung function was evaluated by Dr. Jay Smith, practicing medical doctor and Master of Public Health student at Dartmouth College.

Results: The 21-month project resulted in community ownership and management of the production, promotion, micro-financing, and broad dissemination of improved "Inkawasina" stoves. Environmental Health Committees (EHCs), composed of local leaders and trained promoters charged with educating the public about indoor smoke, improved stoves, and related behavior and environmental health issues, were created in each participating community, and in turn formed three Environmental Health Associations (EHAs) to oversee and administer the micro-loan fund and monitor progress. A cadre of 33 promoters from the EHCs was trained to deliver messages directly to families using educational illustrations about the negative impacts of indoor smoke and the benefits and proper use and maintenance of improved stoves. Radio spots broadcast over a four-month period on a popular radio station reinforced these messages, and various print media were disseminated throughout the communities to raise awareness of the project and elicit participation. "Healthy Kitchen" competitions motivated participating families to take additional steps to create healthy and orderly kitchen environments.

To maximize access to the stoves, Winrock and Centro ECO developed an animal-based micro-loan system to reflect the region's reliance on barter to exchange goods and services. As of August 2007, 491 families had received their loan of an animal "module" (one male chicken or duck and five females, or one male guinea pig and 11 females), which represented 75% of the value of the stove, while the remaining 25% of the value was provided by the family in the form of homemade adobe bricks and labor. A total of 27 entrepreneurs (stove builders and ceramic "elbow" combustion chamber makers) now get paid in animals or cash by the EHAs, which manage the loan fund. By September 2007, improved stoves had been installed in 377 of the borrower households. An additional 36 families chose to purchase stoves with cash.

Stove monitoring and user feedback showed that the Inkawasina stove saves over a third of the wood previously used in open fires. Indoor air pollution (IAP) monitoring within 12 months of stove installation showed that indoor concentrations of respirable particulate matter (measured as PM4) and carbon monoxide (CO) were reduced by more than 80% in a large majority of households. A second, post-intervention monitoring conducted up to 24 months after installation showed less dramatic results, revealing a weaknesses in the ceramic elbows and the need to reinforce messages about effective (and counter-productive) behaviors to sustain the substantial IAP reductions demonstrated by this intervention. According to household surveys and focus group discussions with families and promoters, the majority of families in the district are now aware of the risks of IAP, and many have taken steps to improve kitchen ventilation and keeping children away from smoke as much as possible.

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Annex B. Technical information on stoves promoted in Bangladesh and Peru

Bangladesh Stoves

Early in the project, using data provided from the baseline assessment, the project team reviewed cookstove models and dissemination strategies to select the most appropriate technology for the target populations.

The households in the project areas were using hand-constructed traditional mud cookstoves, which typically accommodate one or two pots and are either portable or affixed to the ground. The average efficiency of these traditional stoves has been rated at an estimated 13-15 percent.[14] These stoves typically are made by women at home. In a few instances, families had purchased cement stoves from local entrepreneurs.

Improved cookstoves made with mud had been developed by the Government of Bangladesh (GOB) under a cookstove program in the 1970s-1980s, but Winrock found very few examples in use in the pilot program area, and households were not very knowledgeable about this type of technology. There was no solid information available on emissions of the GOB mud stove models, but some efficiency data is available. The government-promoted stoves have been estimated to have 25-28 percent thermal efficiency and fuel savings of between 55-58 percent compared to a traditional stove.[15]

The materials for constructing the traditional mud stoves are locally available and the cost of construction is low compared to cookstoves made with metal. The team wanted an improved stove model that would be an easy transition for households, rather than a model that would require radical changes in cooking methods or maintenance. Therefore, the project team decided that the best stove model for the pilot project would be one made of mud.

During the initial community mobilization for the project, the team used participatory tools to identify the types of improved cookstoves households in the selected wards would prefer. The team presented to the communities a number of known mud-constructed improved cookstove model options from Bangladesh and India. The team held community and household discussions and demonstrations to explain the features and characteristics of the various models, and the households voted for the cookstove features that they preferred. The most popular options included chimneys for fixed stoves, and a portable stove that could be moved in and out of the house and used for cooking small quantities of food or for reheating purposes. The portable stove was particularly

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[14] *Khan, A.M.H.R, Development of Downdraft Wood Burning Stove in Bangladesh, Energex 2000: Proceedings of the 8th International Energy Forum, Las Vegas, Nevada. July 23-28, 2000.*

[15] *Ibid.*

important for the target households because many households consisted of only one room and women preferred to cook outside due to lack of space.

Using this information, the team narrowed the list to seven potential cookstoves for promotion. These included improved cookstove models promoted by the Government of Bangladesh, as well as stove models promoted by Appropriate Rural Technology Institute (ARTI), an NGO based in Pune, India. Information on participants' willingness to pay was collected through community-level discussions when the final stove models were selected.

BCSIR 1 pot portable cookstove

The cookstove models selected by the project team and the communities were tested under controlled conditions in the laboratory to obtain baseline performance data on emissions and efficiency. The team performed water boiling tests (WBT) and tests for CO and $PM_{2.5}$ emissions. Based on these tests, as well as community feedback, three cookstove models were selected for promotion in the project based on a combination of factors, including performance and user preference. The most fuel-efficient stoves were 29-50% more efficient when compared to a traditional stove, with the 2 pot fixed stove, 1 pot portable stove, and the VERC Grihalaxmi stove consuming 29%, 35.5%, and 50% less fuel, respectively. The three stoves adopted for dissemination were:

BCSIR 2 pot fixed cookstove with chimney

(1) **BCSIR 1 pot portable cookstove with grate**—this model, promoted by the Government of Bangladesh, features a fuel inlet, a metal grate to increase fuel combustion, and two air inlets at the bottom. This stove cost around Tk. 150-300 (US$2-4), with the higher prices charged to customers outside the project area.

(2) **BCSIR 2 pot fixed model with chimney**—this model, previously promoted by the Government of Bangladesh, is a fixed stove that includes a grate for the first pot hole, air inlets, fuel inlet, and an ash outlet under the chimney. This stove cost around Tk. 500 (US$7).

VERC Grihalaxmi cookstove

(3) **VERC Grihalaxmi**—this third model is based on ARTI's Grihalaxmi stove; however, some design

changes were made, including making the stove portable and using a different quality grate. The VERC Grihalaxmi, as the new model was called, has two grates, air inlets, and a fuel inlet. This stove was selected by the households because it can accommodate small pots, whereas the other two models typically accommodate larger pots. Like the BCSIR 1 pot portable stove, this stove also cost around Tk. 150-300 (US$2-4).

In the second year of the project, additional stove testing for the three models was undertaken in homes under actual use conditions to assess IAP and fuel consumption. Indoor air quality (IAQ) tests included obtaining emissions measurements for carbon monoxide (CO) and particulate matter ($PM_{2.5}$), while stove performance tests included WBTs and KPTs. While initial testing included only newly constructed stoves in simulated conditions, this second testing phase included stoves that had already been in use in households for at least one month.

All testing activities for cookstove selection were led by ARTI with support from VERC and Winrock. Cookstove performance reporting is included as Annex V of the stand-alone Bangladesh Pilot Report.

Peru Stove

The chosen technology for the Peru pilot was an improved woodstove called the "Inkawasina" stove, developed by Centro ECO engineer José Humberto Bernilla. This stove was field tested by 60 households under a GTZ pilot with excellent results. From the project kick-off meetings with municipal and community leaders to the household-level promotion by community promoters, the Inkawasina stove was touted for its ability to reduce indoor smoke, reduce respiratory disease, and reduce the time and physical drudgery of collecting fuelwood. Based on community acceptance in the Ayamachay pilot, the model was deemed appropriate, with some small improvements, for immediate promotion.

In October 2007, after the project was completed, the GTZ program in Bolivia contracted Aprovecho Research Center to assess the performance of the Inkawasina stove, among many others to be promoted in Bolivia. Aprovecho had the following conclusion about the Inkawasina stove design: "The Inkawasi-based stoves are wonderful. Successful use of sunken pots in a chimney stove is the best way to reduce fuel use and IAP level in a home. The stove design is well done from a heat transfer and combustion efficiency standpoint, and they are appropriate solutions to local needs using local materials. Also the stoves fared quite well in all tests that were conducted." With reference to the Inkawasina stove dissemination strategy in Peru, the Aprovecho report also noted, "The Peruvian stove dissemination strategy is one of the best I have seen. The strategy and cost for reaching the people with greatest need living in remote areas is excellent. It is encouraged that the designs and performance results of this project be shared with the

greater stove community in the hope that a similar strategy can be followed in other areas worldwide."[16]

The Inkawasina stove incorporates clean and efficient combustion concepts, particularly "Rocket"[17] stove design principles, to increase energy efficiency while reducing emissions and indoor pollution. A chimney exhausts the remaining pollutants. The original Inkawasina stove used an all-metal chimney; however, the design was modified under this project to replace the metal with adobe for the indoor portion of the chimney to reduce costs. The stove is built on-site using locally available materials, including adobe bricks, locally fired ceramic "rocket" elbows, and cement (see diagram below).

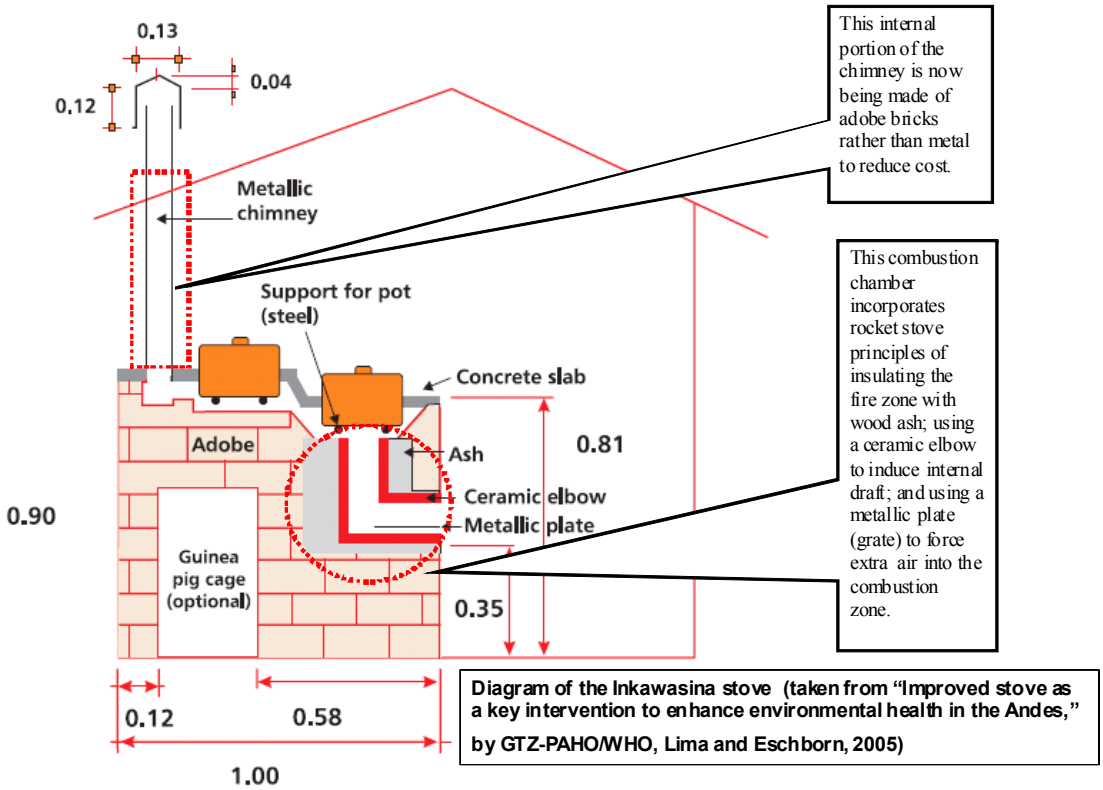

Diagram of the Inkawasina stove (taken from "Improved stove as a key intervention to enhance environmental health in the Andes," by GTZ-PAHO/WHO, Lima and Eschborn, 2005)

Detailed sketch of the Inkawasina stove

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[16] *MacCarty, Nordica. Results of Testing and Existing Stove Design Recommendations: Peru. Aprovecho Research Center. Oct. 2007.*

[17] *The "Rocket" stove was developed by Aprovecho Research Center. The principles of rocket stove design are incorporated into a wide range of stove designs in numerous countries. Key elements include: an insulated combustion chamber to increase the temperature within the fire zone; a grate to elevate the fuel magazine and allow adequate air (oxygen) to mix with the fuel gases; and an internal chimney that creates a natural draft within the combustion chamber, forcing the hot gases to rise and fresh air to enter the combustion chamber. These features result in a better mix of the fuel gases and oxygen and very high temperatures, such that the combustion is more efficient and generates fewer harmful pollutants. Additional design features, such as adding a "skirt" around the pot or sinking the pot closer to the flame, increase heat transfer efficiency, and thus facilitate a reduction in fuel use.*

Winrock and Centro ECO designed a dissemination strategy that would make the Inkawasina stove affordable and accessible to interested families in the district and foster ongoing access in the future. Local artisans produce the "rocket" elbows, and the stoves are constructed by a select group of promoters in each EHC trained as stove builders under this project. Both the elbow makers and stove builders receive payment for their services from their respective EHAs.

To keep the stove cost low and to maximize the engagement or "buy-in" of the stove owner, the family must make the adobe bricks for the stove body, using locally available mud mixed with grass in wooden molds and dried outdoors. Each family must further contribute labor to assist the stove builder when he is constructing the stove in the family's kitchen. This contribution in adobe and labor by each family represents about 25% of the overall stove cost. The stove builders are responsible for buying or preparing other materials such as the cement plate to hold the pots, iron bars, rocket elbow and chimney cap.

The cost of the Inkawasina stove components are shown in the table below, with the family contribution highlighted:

Inkawasina wood stove cost breakdown

Component	**Cost: *soles***	**US$**	**Notes**
Masonry	27	7.54	Cost of mason's labor
Rocket elbow	17	4.75	Ceramic elbow
Metal parts	22	6.15	Iron bars, chimney hat and outdoor pipe, chimney paint, wires
Other parts	15	4.19	Cement plate, sand, wood mold for stove parts
Adobe bricks	33	9.22	Adobe, mud, wood ash (all provided by stove owner)
Assistant	5	1.39	Manual labor (provided by stove owner)
Total	**119**	**33.24**	

To supply the stoves with the ceramic "elbow" combustion chamber, several local promoters were trained as ceramic artisans. These artisans are now responsible for supplying all stove makers with this key component of the Inkawasina stove.

Annex C: Behavior change communication and social marketing products

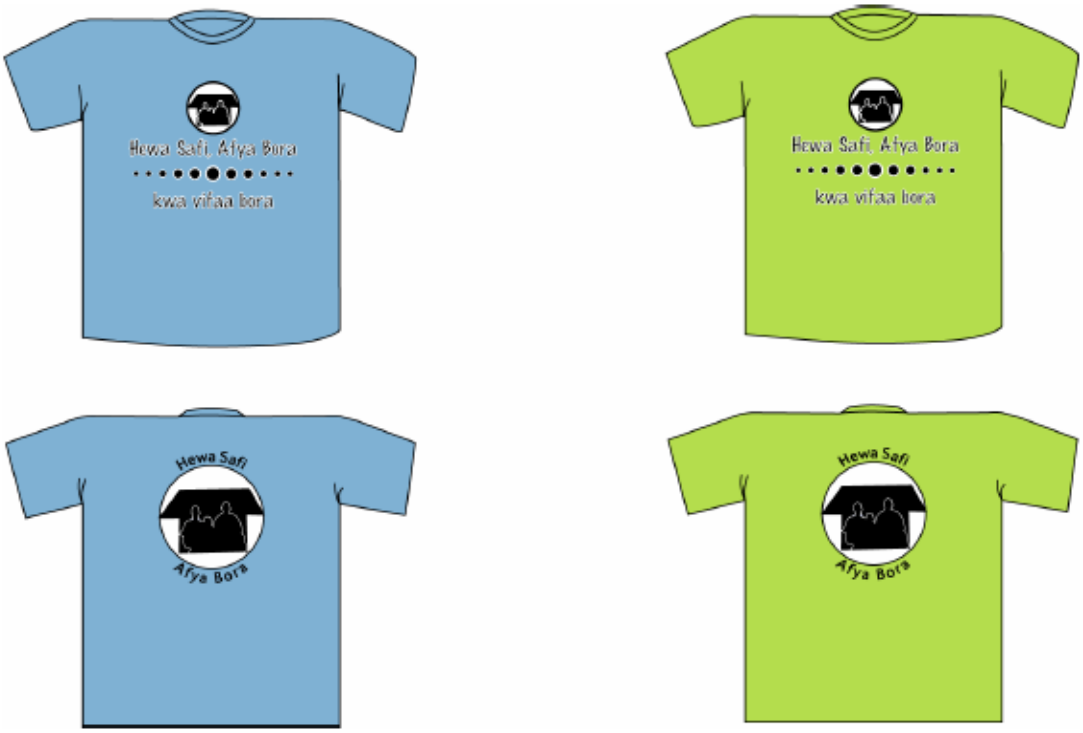
Kenya Social Marketing Materials

Sticker

Banner

Hewa Safi, Afya Bora translation: Clean Air, Better Health

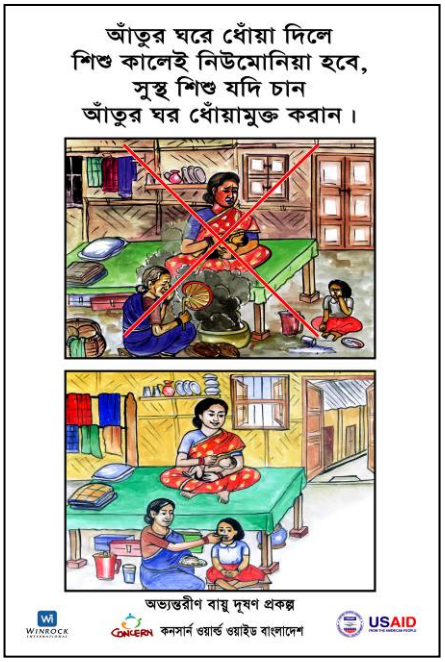
T-Shirt



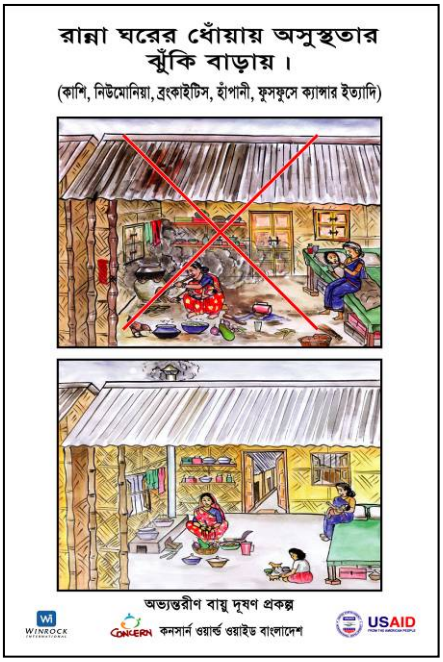
Hewa Safi, Afya Bora translation: Clean Air, Better Health

Flyer

Bangladesh Pilot Behavior Change Communications Material

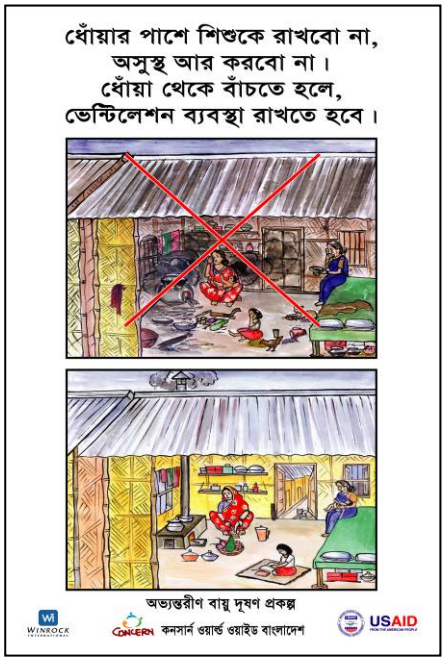


"Smoking the room of newborn children will cause pneumonia in infants. If you want newborn children to be healthy then keep their rooms smoke free." **

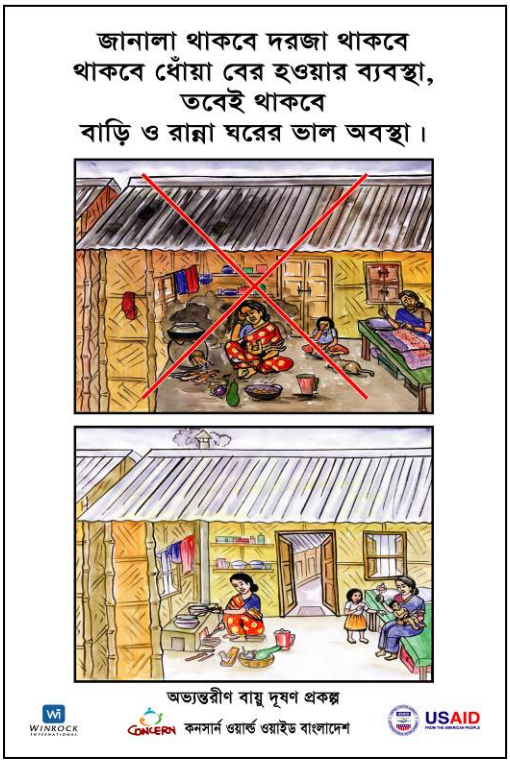


"Exposure to kitchen/cooking smoke increases the risk of diseases (cough, pneumonia, bronchitis, asthma, lung cancer, etc.)."

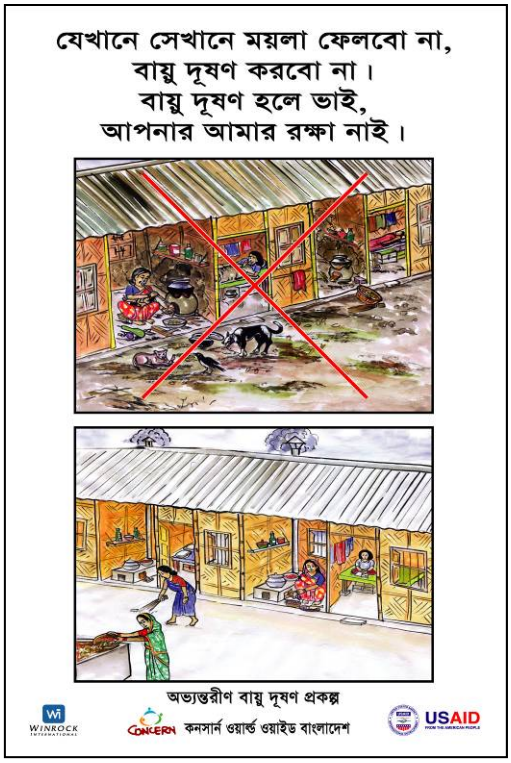
** ***NOTE:*** Local traditions hold that smoke helps drive off evil spirits. The IAP posters sought to deliver the message that smoke actually is very unhealthy for infants.



"We will not keep our children in smoky environments and make them sick. We need good ventilation to keep the cooking environment smoke free."



"Doors and windows help remove smoke and improve indoor environments."



"We will not pollute the air/environment by throwing garbage everywhere."

"We will not burn plastics and polythene and pollute the indoor air. Indoor air pollution causes diseases."

Peru Pilot Behavior Change Communications Material

Illustration demonstrating the need for small twigs and logs to be cut into small pieces for use in Inkawasi improved stoves

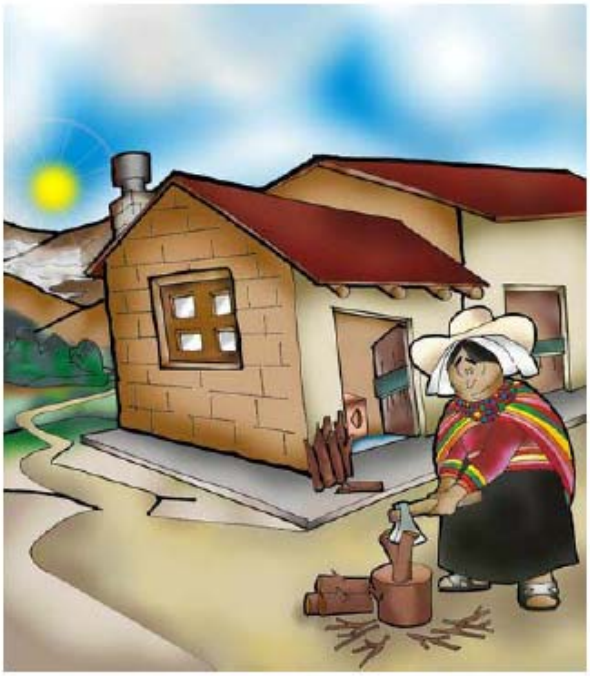


Illustration demonstrating proper use of a small amount of firewood at a time in an Inkawasi improved stove

Illustration depicting the smoke that is released into the room when one hole of the stove is left uncovered.

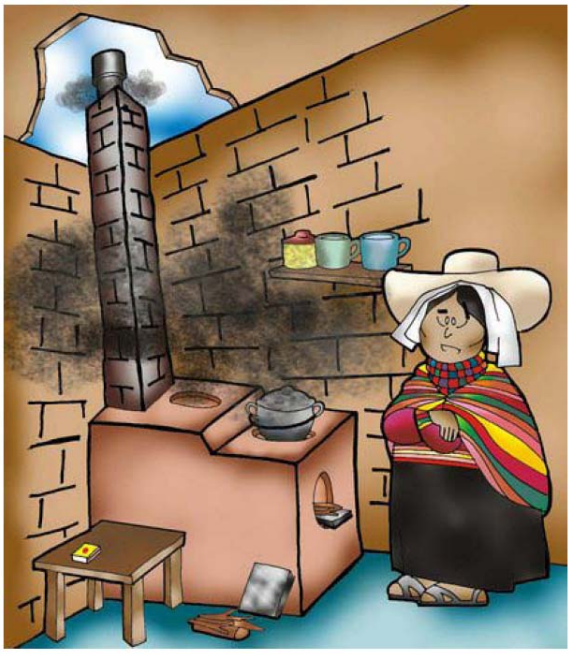
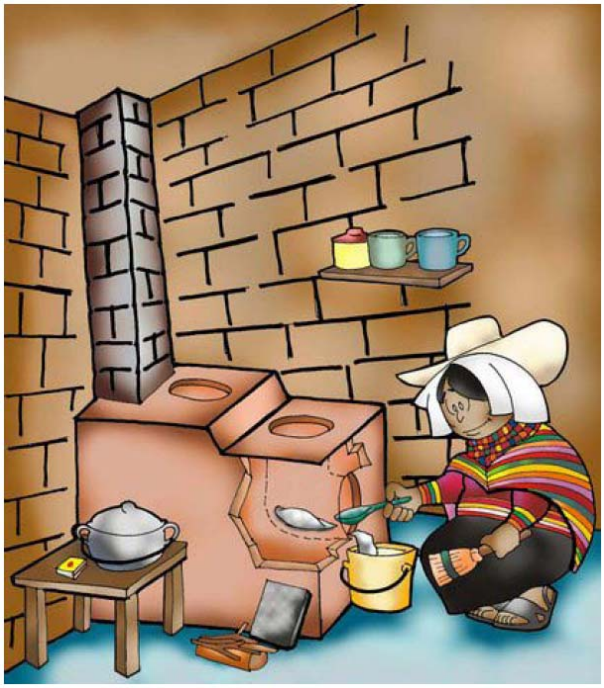


Illustration depicting the proper release of smoke outside the house through the chimney when the second stove hole is properly covered.

Illustration demonstrating proper chimney maintenance techniques.

Illustration demonstrating proper regular ash removal from the combustion chamber of the stove.



Annex D: Additional references and resources

USAID Environmental Health website: www.ehproject.org

Partnership for Clean Indoor Air (PCIA): www.pciaonline.org/

World Health Organization: www.who.int/indoorair/en/

HEDON Household Energy Network and HEDON Clean Air special interest group: www.hedon.info; http://www.hedon.info/goto.php/CleanAirSIG

Bioenergy lists: www.bioenergylists.org

UC Berkeley/Kirk Smith website: http://ehs.sph.berkeley.edu/krsmith

PERU Healthy Kitchen/Healthy Stove Pilot Project report: http://pdf.usaid.gov/pdf_docs/PDACN009.pdf

Bangladesh Commercialization of Improved Cookstoves for Reduced Indoor Air Pollution Pilot Project report: http://pdf.usaid.gov/pdf_docs/PNADO851.pdf