



## **Ecological Cookers: An essential Element in Bettering Household Health**

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### **Introduction**

“Alternative cooking technologies are perhaps the most important tools we have to reduce human suffering and relieve environmental degradation.” <sup>1</sup>

Alternative energy technology specifically in the form of improved cook stoves alleviate serious problems in the areas of HEALTH, ENVIRONMENT, ECONOMICS, and ADD VALUE TO THE LIVES OF WOMEN and CHILDREN in the developing world.

Here, proven health problems such as respiratory ailments, cataracts, monoxidie in bloodstream of pregnant women, lung cancer, burns, impure water, lack of nutrition because of lack of fuel, labor burden on women and children looking for fuel and breathing particles in polluted indoor air are discussed.

After a brief survey of improved stove programs and their reported impacts and observations, lessons learned from programs in Africa, Asia, Central America, and the ecological cookers program in Bolivia, a vision for future remedies will be suggested.

## 1. OVERVIEW

**HEALTH:** Several billion people suffer regular bouts of diarrheal illness because of polluted water. Many suffer respiratory and eye ailments because of the extremely smoky cooking conditions sometimes equivalent to smoking 10-20 packs of cigarettes per day. Much malnutrition is caused by undercooking of food and the practice of single pot cooking imposed by fuel shortages. The toll is the death of 14 million young children each year and the life expectancy in many countries is less than 50 years.

**ENVIRONMENT:** Unsustainable use of biomass as fuel is causing environmental degradation in the third world. Even though the third world consumes little energy compared to the first world, **90% of its energy is used for cooking food**. As the 21<sup>st</sup> Century began, UN/FAO estimated that fuel shortages affect at least 2.4 billion people. The forage for fuel contributes to deforestation, soil erosion, water pollution, loss of soil fertility, and ultimately, desertification. Sub-Saharan Africa is a dramatic example of this process.

**ECONOMICS:** Many families are forced to spend more on cooking fuel than on food, affecting nutrition, health and their ability to acquire adequate health care.

**EQUALITY:** In many areas of the developing world, cultural practices condemn women to the slavery of arduous foraging for fuel, which could be alleviated by the use of improved cooking devices. <sup>2</sup>

## **The common denominator in these inequities is cooking fuels.**

Burning coal, LPG gas, biomass, or animal dung has been identified as directly causing chronic respiratory diseases in adults and children. Studies determined that cooking fuels produce unacceptable levels of indoor air pollution during cooking, as indicated indirectly by blood COHb concentrations. Use of biomass and animal dung fuels deprive the soil of recycled nutrients and reduce crop yields along with the land's capacity to support livestock.

The lack of cooking fuel forces households into strategies that affect nutrition. Fuel availability affects cooking habits and food availability. There are identifiable links between fuel, food, water, children and women's time and their health. All of these factors impact quality of life, even reducing life spans. Dependence on fossil fuel for cooking energy is not sustainable.

### 1.1 INDOOR AIR POLLUTION

Reducing smoke inhalation and related illnesses, as well as burn related injuries caused by current cooking conditions is the principal motivation for the implementation of these stoves. The number one cause of death in

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children under the age of five in Central America is advanced respiratory illness. This has been directly linked to the use of the open fire for cooking in the home.<sup>3</sup>

In the article "HEALTH EFFECTS OF INDOOR AIR POLLUTION", Dr. Mr. R. Panadey establishes a clear relationship between indoor air pollution caused by

domestic fires for cooking and heating purposes with Chronic Bronchitis and Chronic Obstructive Pulmonary Disease in adults. Furthermore, the article advises us that Chronic Obstructive Pulmonary Disease is a leading cause of death and disability of human life around the world. The study states that indoor air pollution is a definite cause of Acute Respiratory Illness (ARI) in children.

Dr. Panadey informs us that based on an analysis of 260,162 persons over 20 years old living in Indian households that use biomass as their primary cooking fuel, those persons have substantially higher prevalence of active

tuberculosis than persons living in households that use cleaner fuels. Additionally, the incidence of asthma is rapidly increasing in the developing world, probably linked to indoor air pollution.

Relationships between low birth rate and the presence of CO in mothers' and babies' bloodstreams is demonstrated.

This important study concludes that domestic smoke pollution is responsible for a relatively high percentage of morbidity and mortality mainly due to respiratory diseases in many parts of the developing world. The author challenges, "immediate attention to this issue is required to reduce the disease burden caused by indoor air pollution in these countries." <sup>4</sup>

In their research published under the titles of "INDOOR AIR POLLUTION AND TUBERCULOSIS: A RETROSPECTIVE STUDY", and "INDOOR POLLUTION AND CATARACT", Doctors IMELDA D. SORIANO and RODOLFO J. SORIANO JR., demonstrated that development of more severe cases of TB have been correlated with the use of fuel-wood in cooking and suggest a link between cooking smoke and cataracts. <sup>5</sup>

Auke Koopmans' editorial titled "BIOMASS ENERGY, INDOOR AIR POLLUTION AND HEALTH", informs that results from studies carried out in

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developing countries indicate that the particulate concentrations from traditional biomass using stoves are often 10 or more times higher than standards set by the U.S.

Environmental Protection Agency. He explains that exposure to these high levels of pollution has been consistently associated

with acute respiratory infections (ARI), the largest single cause of morbidity and mortality worldwide.

In fact, Koopmans maintains that "indoor air pollution" is after "clean water and sanitation", the second largest environmental burden of disease when expressed in Disability Adjusted Life Years (DALYs). <sup>6</sup>

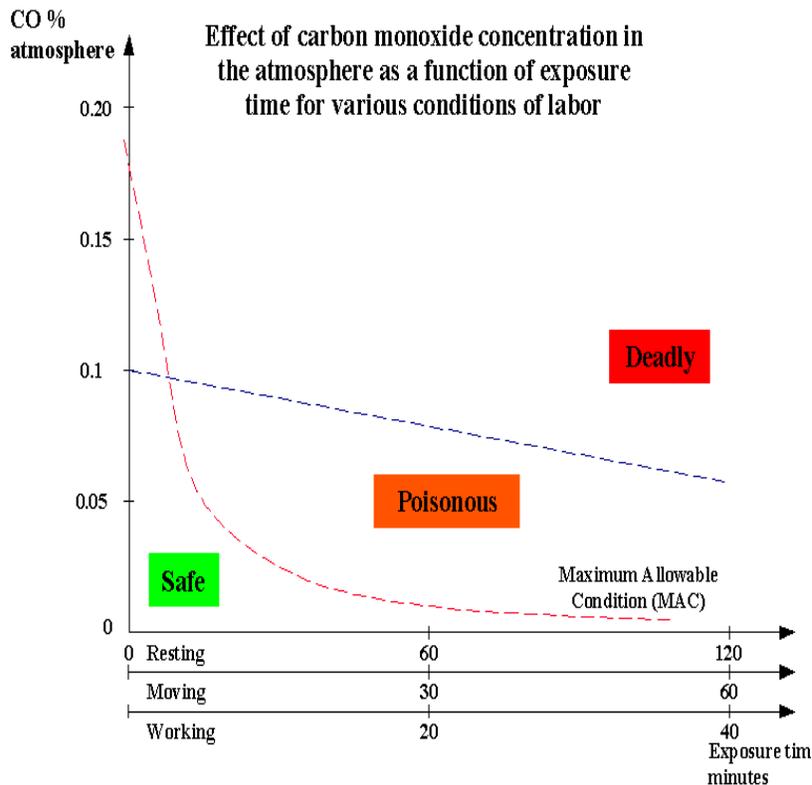
Table 1.1 shows health implications of major pollutants that are normally emitted from biomass burning.

**Table 1.1** Mechanisms of principal health effects from major pollutants.

Pollutant	Mechanisms of health effects
Carbon monoxide	Inhalation into respiratory system Absorption into blood from lungs Elevated carboxyhemoglobin (COHb) levels Reduced oxygen to body tissues Possible cilia-state impact on lung clearance
Particulates	Inhalation into respiratory system Deposition in respiratory tract Irritation and toxicity
Benzo (a) pyrene	Inhibition into respiratory system Deposition and absorption in lungs Metabolic activation Precursor to cancer
Formaldehyde	Irritation of mucosa Toxicity to cilia Reduction in lung clearance ability Possible carcinogen

Source: Smith, 1987

**Table 1.2** Effect of carbon monoxide concentration in the atmosphere as a function of exposure time for various labor conditions.



"Studies conducted on the estimation of emission factors in traditional cookstoves using solid biomass (Ahuja et al 1987), showed that CO emission ranged from 13-68 g/kg for fuelwood to 26-67 g/kg for dung cakes and 20-114 g/kg for crop residues; for suspended particulates the values ranged from 1.1-3.8, 4.1-7.8 and 2.1-12.0 g/kg for these fuels, respectively. The results indicated that emissions from both dung cakes and crop residues are 2-3 times higher than fuel-wood on a per unit heat delivered basis. Unfortunately, the predominant fuels used in the rural Indian households are either dung cakes or crop residues (due to fuel-wood resource scarcity).

This has resulted in a large build-up of the pollutants in the kitchen as a result of the inherent poor ventilation conditions. This is the reason that the most prevalent polluted environment in the world is to be found indoors, in the rural areas of developing countries. To a large extent, it affects the health and productivity of the exposed masses of rural people in the developing world.

Based on those studies mentioned above, two types of respiratory diseases related to smoke from burning bio-fuel have been established, namely: Chronic Obstructive Lung Disease (COLD) in adults and Acute Respiratory Infections (ARI) in infants and young children. Both of these diseases are prevalent among families using biofuel in traditional open-fires or traditional stoves in unvented conditions. "Cor Pulmonale" (heart disease secondary to COLD) has also been found to be prevalent and to develop earlier than average in non-smoking women who cook with unvented biomass stoves (Panadey 1988). Other health effects such as adverse pregnancy outcome (low birth-weight), cancer, etc. are also suspected from biomass burning smokes (tobacco smoking as well as unvented cooking fire). For detailed discussions on biofuel and health, please refer to Smith (1987), WHO (1992).

Panadey (1985) studied the impact of domestic smoke pollution on the respiratory functions and established a direct link between smoke pollution and chronic bronchitis. His study showed a positive interaction between domestic smoke pollution as well as tobacco smoking on lung function.

Another study undertaken in rural China, where fuel-wood, crop residues and coal are used in households (WHO 1992), reported that among the first ten causes of death of rural Chinese, respiratory diseases rank first, with a mortality rate 73% higher than their

counterparts in cities, in spite of a much worse level of outdoor air pollution in cities. Smith (1986) studied the exposure of women to indoor air pollutants, during cooking on traditional stoves using biomass fuel, in four Indian villages. It was found that total suspended particulate (TSP) exposure averaged nearly 7 mg/m<sup>3</sup> and benzo-a-pyrene (BaP) about 4,000 mg/m<sup>3</sup>, which is many times more than the permissible limits. In addition, due to improper ventilation and air movement in the kitchen, women and children are exposed to the combined effect of elevated temperature and high humidity in the kitchen, which makes working conditions very uncomfortable, especially in the hot and humid climates.

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Indian girl carrying dung for fuel

Thus, it can be concluded from this discussion that the effect of the pollutants (emitted from combustion of biofuels during cooking) on the health of women and children should be of grave concern. There is a need to use various strategies, either singly or in combination to curb the level of emissions."  
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## 1.2 RELATED HEALTH ISSUES

The World Health Organization (WHO) has recently estimated that some 1.6 million premature deaths each year come from the use of solid fuels (biomass and coal).<sup>8</sup>

Waterborne diseases such as cholera, typhoid fever, gastroenteritis, dysentery, and

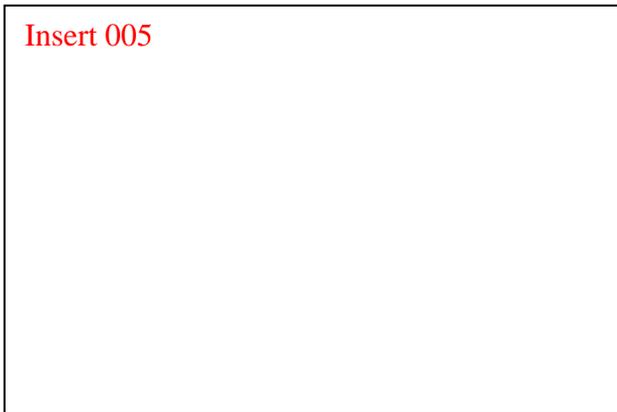
infectious hepatitis kill more than 400 developing-world children every hour, and result in the loss of billions of hours of worker productivity each year. Water is uncommon in developing countries, and two out of three people in the world must fetch water from outside their homes.<sup>9</sup>

In developing countries, the burden of disease caused by contaminated water and a lack of sanitation continues to be staggering, particularly among young children. Diarrhea is most often caused from contaminated water by microbes entering the mouth.

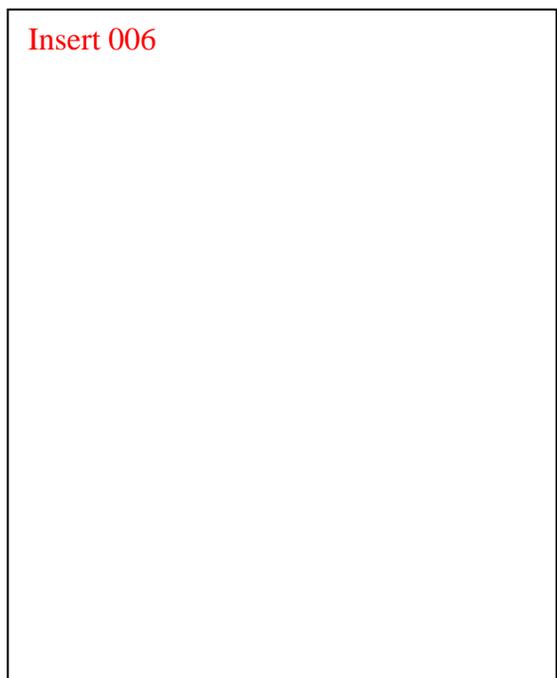
According to the United Nations Children's Fund (UNICEF) diarrhea is the most common childhood disease in developing countries. Dehydration resulting from diarrhea is the leading cause of death in children under the age of five, annually killing an estimated five million children. Diarrhea is also the most common cause of child malnutrition, which can lead to death or permanently impaired mental and physical development.<sup>10</sup>

HELPS INTERNATIONAL is an organization working with improved Cookstoves in Guatemala. In the HELPS INTERNATIONAL web page, Don O'Neal discusses an often-overlooked aspects related to health. "Open fire cooking is the cultural way to cook in rural Guatemala. It is how their mothers cooked and their grandmothers before them. It is done without thinking about other alternatives. It also provides a nice place to sit and talk. *It is also very dangerous!* Cooking on open fires creates two major hazards".

### **Burn injuries—**



Like this leg burned when the lady's skirt caught fire.



Other causes of major burn injuries are:

*Face burns* from falling into the fires or hair catching fire as the lady blows on the fire to keep it burning.

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*Eye injuries* from a popping fire, usually caused from blowing into the fire.

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Eyes are also often damaged in a hair fire as well.

*Hand burns* created from a small child falling into the fire.

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The houses are small usually 10 by 12 feet with the open fire in the middle of the room. Children playing or learning to walk in these conditions makes it easy for accidents to happen.

Respiratory problems — According to the World Health Organization, one out of five children in

Guatemala does not live to age 5. They further state that the leading cause of death in this age range is acute respiratory infection (from breathing the heavy smoke from cooking fires).

From the day they are born, the children are carried on their mothers' back while they cook over the open fires.

While respiratory infections are not as visual as burn victims, the results are equally devastating and are a silent killer.

Stoves get the fire off the floor preventing skirt fires, kids falling into it, and remove the smoke from the house. Stoves save lives!

It also is a more convenient way to cook for the ladies, especially for pregnant women who report that cooking standing up is especially appreciated.<sup>11</sup>

### 1.2.1 Gender relationship to health

The obligation to provide both water and fuel for domestic use, particularly in conditions of increasing environmental degradation, is a massive burden on poor urban and rural women and girls. In addition, the health effects of domestic use of biomass fuels (wood, dung, agricultural residues) and coal are suffered largely by women. Important issues can be summarized as follows:

- Women are hit hardest by shortage of fuel, since the onus is on them to find solutions.
- Household coping strategies can affect nutritional status since fuel availability affects cooking habits and food availability.
- Better understanding is needed of the health impact of restricting poor communities' access to natural resources.
- The linkages between fuel, food, water, women's time and women's health warrant further exploration.
- Dung-work illustrates the linkage between women's work and their status.
- Where biomass fuels are commonly used, similar rates in women and men are now being found for diseases such as chronic bronchitis and *Cor Pulmonale*; age of onset of *Cor Pulmonale* in women is early.
- Women's respiratory disorders are linked to domestic exposure to cooking smoke; however, respiratory disease in women often goes untreated.
- Undetected pneumoconiosis in rural women may be caused by a combination of dust from maize grinding and smoke from biomass fuel.<sup>12</sup>

## 2. IMPROVED COOKSTOVES AS A SOLUTION

“Field evidence from many countries in Asia, Africa and Latin America shows that the introduction of Improved Cookstoves (ICSs) has brought considerable benefit to rural and poor urban households.”<sup>13</sup>

There have been many approaches to the health, economic, social and environmental problems associated with household energy issues. A survey was distributed soliciting information on improved stove programs or alternative cooking devices from around the world. Some of those have been selected as representative of best practices in this very important issue.

### 2.1 **Winrock International India**

India has one of the world’s largest improved cookstove programs. About 33 million improved Cookstoves have been disseminated since 1985. In their report titled “IMPROVED COOKSTOVES DISSEMINATION IN INDIA: LESSONS FROM THREE STATES”, the authors conclude that one cannot assume that stove users appreciate more efficient stoves or that the users especially value fuel savings. Improved stoves can be appreciated and adapted for other benefits that they offer such as removal or reduction of smoke from kitchens, cleanliness and time saving. They claim that the study establishes a clear role for subsidies in a stove programme.<sup>13</sup>

### 2.2 **Intermediate Technology Development Group – Kenya Africa**

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Here is an example of the Upesi Stove.

Hellen Owala informs us of ITDG’s work in Kenya. Their program is called, DEVELOPMENT AND MARKETING OF RURAL DOMESTIC STOVES IN WEST KENYA. To-date more than 100,000 Upesi stoves have been disseminated, of which surveys show 95% are in use. They have concluded that a commercial approach

is important for sustainable dissemination of improved stoves.<sup>14</sup>

Another innovation in this project is the inclusion of devices that use the heat retention principle to finish the cooking started over an external heat source.

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There will be more discussion on this cooking principle.

### **2.3 Senegal Household Energy Program**

This program covers the producer side of household energy, including forestry products and consumer panels. The 5 million US\$ funding this project comes from GTZ.

### **2.4 Democratic Republic of Congo**

Swedi Elongo, Executive Director of the Centre of Action for Sustainable and Integrated Development in the Communities, writes about a program called IMPROVED COOKSTOVES AND SOLAR COOKERS. He says that wood, stubble, dung and grass are used daily in about 90% of the DRC's households as energy for cooking, heating or lighting. They are acutely aware of the harmful effects of biomass smoke on health.

The author maintains that in the context of the DRC, where more than 95% of rural energy consumption is considered to be at the domestic level and consisting of biomass, it is particularly true that women hold three roles as the household energy generators, managers as well as users. They have determined that energy and water cannot be separated from gender equity. Also their position is that gender mainstreaming has to be

incorporated in all energy and water related aspects. We are told that about 33 million rural inhabitants now relying on biomass energy should be interested in improved stoves and solar cookers. They stress that this project has succeeded in decreasing the number of sick persons suffering from respiratory infections, pneumonia and cataract.<sup>15</sup>

## 2.5 Southern Africa's PROBEC

The Programme for Biomass Energy Conservation in Southern Africa has shown that with a comprehensive package of solutions it is feasible to reach multiple, long lasting environmental, economic and social benefits. These programs demand an integral approach both on horizontal as well as on vertical levels. The author proclaims that excellent results have been achieved with their approach in both Eastern and Western Africa.

ProBEC's contribution to the UN Millennium Development Goals is featured:

- **Additional jobs will be created in the informal sector through production and marketing of improved technologies. This will reduce the number of people whose income is less than 1 \$ a day and thus contribute to Eradication extreme poverty and hunger (MDG 1). Also job possibilities for youth are given (Target 18).**
- **Women are primarily targeted in trainings and extension services. This promotes gender equality and empowers women (MDG 3), both on intellectual as on income level.**
- **Smoke reduction through BEC measures has been proven to reduce respiratory diseases by 50% both for women and children. This contributes also to the reduction of child mortality (MDG 5).**
- **Reduced work burden in poorer households and better energy supply for better food will help combat HIV/AIDS (MDG 6), especially for the PLWHA+. HIV/AIDS awareness being integrated part at all programme interventions will enhance the fight against the pandemic.**
- **Reducing woodfuel consumption saves forest areas; the use of more energy efficient and alternative technologies will reduce CO2 emissions. This will directly contribute to environmental sustainability (MDG 7) and thus, to the international Convention to Combat Desertification. 16**

## 2.6 New Dawn Energy Systems South Africa – Vesto Stove

Rina King, the contact person for the commercial dissemination of the VESTO STOVE responded to our survey saying, “Interestingly, we are also

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working on a Solar Cooker, Wood stove and retained heat bag together. We are a looser aggregation than you describe, although GTZ is putting forward a business case to combine the 3.” Through 9 sales persons they reach out to the community and are working with GTZ to distribute retained heat cookers and solar cookers.

Due to the significant improvement on the emissions from a three stone fire, there are large health implications for the users of the stove. Respiratory disease is amongst the 4 top reasons for death in children under 4 years old. The fire is also

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contained and will reduce the injuries due to burns suffered by South African teenagers – the fourth highest reason for death amongst teenagers. As 2 to 3 times less wood is required, women will be less exposed to dangers when collecting wood and the problems with backs resulting from carrying wood will reduce concomitantly.

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The project aims to sell 500 stoves a month by the end of 2003.<sup>17</sup>

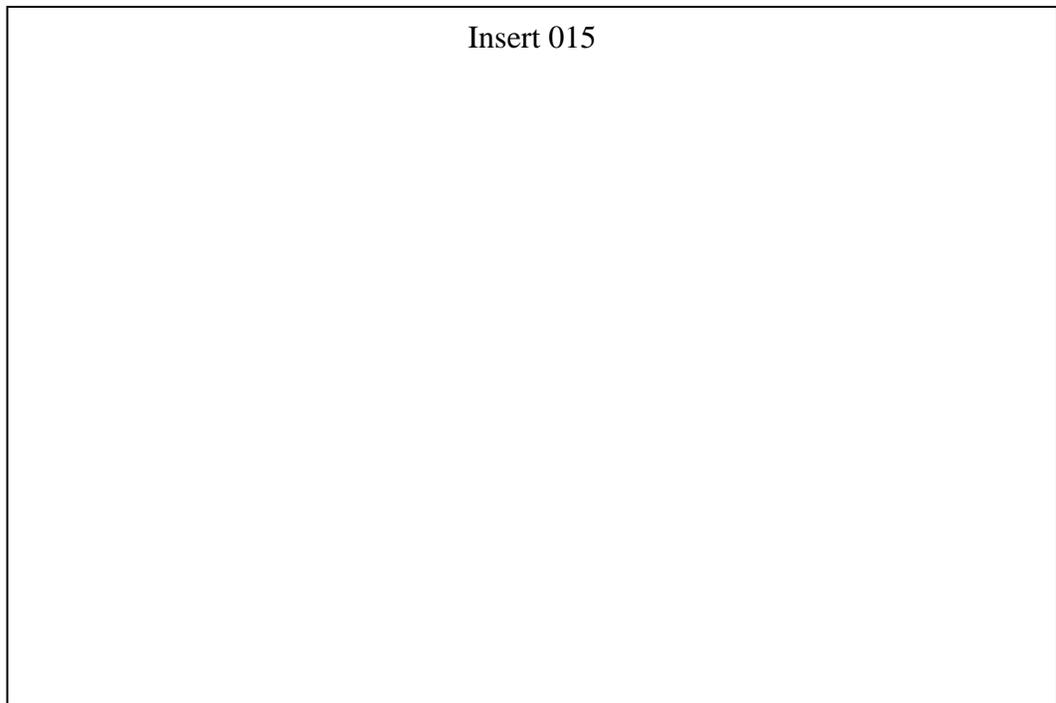
## 2.7 Appropriate Rural Technology Institute - India

A Shell Foundation Grant finances the well-known Dr. A. D. Karve's program, "Commercialization of Biomass Based Fuels and Cooking Devices in India". The project that was launched in January 2003 is still in the initial phase, but by December 2005, they say it will have created at least 100 rural micro-enterprises dealing with improved biomass fuels and cooking devices. They project at least 100,000 households routinely using these devices by that time.

Micro-credit is identified as an important factor in the future success of their activities. Initial studies conducted by ARTI show a substantial reduction in both carbon monoxide and suspended particulate matter in the kitchen.<sup>18</sup>

## 2.8 Ashden Award winner – Eritrea Stove Project – Africa

Robert Van Buskirk reported to the “Stove list” on June 19 of this year that the First place prize winner in the Food category for the Ashden Award was the African Eritrea Improved Stove Project. He identified himself as the verifier for carbon credits since this is the first known stove project to be qualified for those credits. His report can be read at <http://www.punchdown.org/rvb/mogogo/index.html> .<sup>19</sup>



Currently they are installing about 3,000 stoves a year and their goal is to increase to 25,000 per year.

One difference between the Eritrea program and the Second place winner in the same category is their methodology. Eritrea uses a community-based approach, where each woman learns how to build her own stove with as much local materials as possible. Pictures can be seen at [www.ashdenawards.org](http://www.ashdenawards.org)

Rogério Miranda, also addressing the STOVE LIST, states that, “apparently this community approach was preferred by the Ashden judges over PROLEÑA’S approach of a central factory and commercialization strategy.”

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## 2.9 Proleña

Since 1998, PROLEÑA and Trees Water and People have developed the new Ecostove, which addresses the main problems regarding traditional woodstoves. It produces a *higher efficiency (50% savings of fuelwood)* than the three stone fire, a *smoke-free* indoor environment due to chimney, keeps *the pots free of soot*, allows for the *cooking of multiple pots* at the same time, *improves the appearance* and aesthetic of the kitchen, it is portable and can be mass produced, *facilitating quick dissemination*.

Rogério's excellent article, HOUSEHOLD HEALTH and ENERGY IMPROVEMENT WITH PROLEÑA'S ECOSTOVE, explains how the Ecostove was designed primarily for women's concern for their family health, as well as to minimize the environmental impact on forests.

In a recent email communication, Rogério wrote, "Up to now we have



produced and sold over 3,000 Ecostoves in Nicaragua, over 500 Justas stoves in Honduras, and we are introducing the Ecostove to both Brazil and Bolivia right now."

This stove is based on the "Rocket" principals developed at Aprovecho Research Institute in the USA.<sup>21</sup>

## 2.10 Trees, Water and People – Honduras / El Salvador

TWP, Aprovecho Research Center and the Honduran Association for Development have teamed up to build more than 2.000 stoves in western and central Honduras. Rotary Clubs and Rotary International have helped fund the projects.

According to Stuart Conway, one of the strengths of the project has been the participation of local women in the design and promotion of the stove.<sup>22</sup> He says that millions of families still need improved cookstoves in Central America. The Justa stove is also based on "Rocket" stove

technology, but is made in the home out of bricks or adobe with a metal griddle for cooking tortillas.

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Surveys of women report 66 to 70% reduction in fuelwood use compared to the traditional stoves. Additionally, a 70% saving in time cooking and significant reduction in respiratory (asthma, bronchitis, etc.) and eye problems for women and children were reported.

By 2004 Stuart expects to have built 1,500 more Doña Justa stoves in El Salvador.

In an email conversation with Lisa Buttner from Winrock International, Stuart relates that TWP, Aprovecho, and their Central American partners have built more than 5,800 fuel-efficient stoves since 1998. Proleña has done 3,000 of those in Nicaragua. The other stoves were built as follows: Honduras – 2,000, El Salvador – 550, Guatemala – 250.

## 2.11 Masons on a Mission

This organization is located in the northeastern part of the USA and does most of its work in Guatemala. They are principally funded by volunteers, and work directly with locally trained villagers. Pat Manley <sup>23</sup> and his volunteers have built about 1,000 stoves so far and estimate that 10,000 Mayans have benefited. Pat also works with HELPS to buy and install their stove.

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## 2.12 Helps International

HELPS International <sup>24</sup> has developed a line of stoves to replace the three stone fires used in rural Guatemala. The stoves are efficient, fast and eliminate many hazards of the open fires.

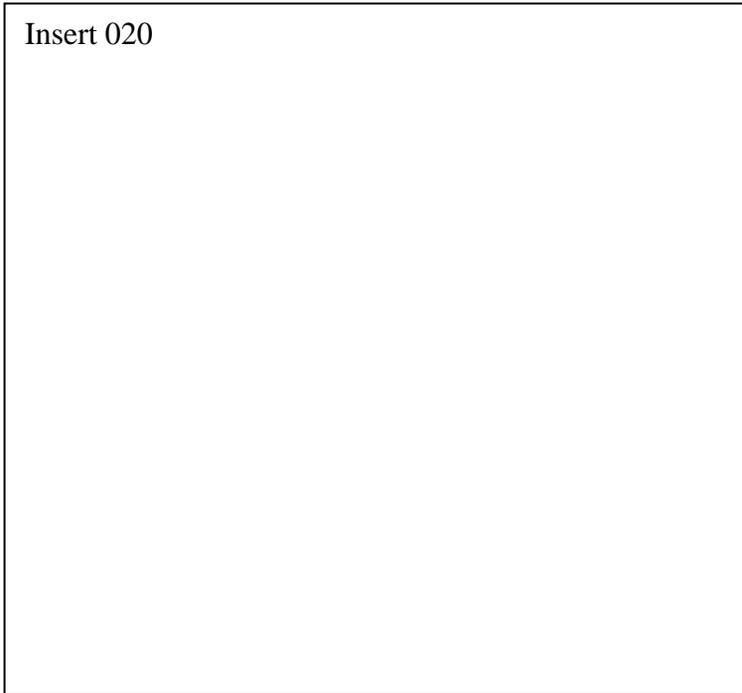
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The stoves have been extensively tested and have been accepted by the ladies in the villages. HELPS has two stove types, each optimized for a particular need.

The plancha stove is made for cooking tortillas and other daily cooking needs.

The Nixtamal cooker is a large volume, efficient potboiler.

Both stoves provide a 60-70% savings in wood consumption while providing a safer cooking environment.

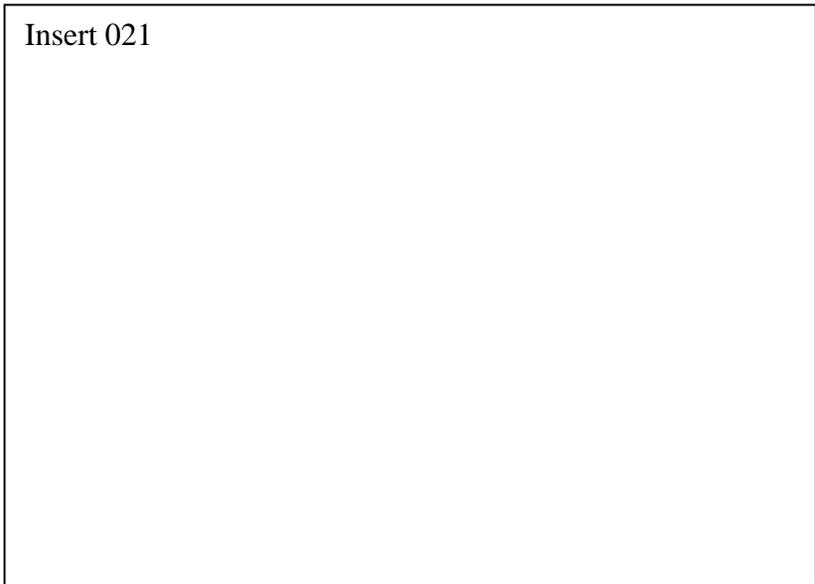


Features include:

- Improved safety
- Smoke removed from house
- Substantial reduction in wood consumption
- Off floor cooking

### 2.13 SOS Solar Ovens

Michael Port<sup>25</sup>, Executive Director of Persons Helping People and the Solar Oven Society also responded to the survey. The Solar Oven Society went



into mass production of their model SOS Sport last fall. SOS ships to individuals and groups, having shipped to 31 countries to-date. Their biggest project so far is 400 ovens in Afghanistan.

Their mission is to provide low cost, effective, durable, attractive solar ovens, education and

training to help families in sun-rich but fuel poor countries improve their health, time utilization, nutritional, financial and environmental resources.

A unique feature of this improved cooking device is that it utilizes about 2 kilos of recycled post consumer plastic soda bottles for its outer case. This improved cooker is claimed to be one of the best-insulated ovens on the market and is designed to be assembled in developing countries. Their web site is [www.solarovens.org/](http://www.solarovens.org/)

Responses to the survey demonstrate that the need for improved cooking devices is recognized worldwide. Although the major programs focus solely on biomass devices, with increasing frequency the combined use of efficient biomass, retained heat and solar cookers is being implemented. In Bolivia one of the world's most successful improved cooking technology transfer programs has been advancing since 1999.

### 3. Ecological Cooking – An Integral approach to Improved Cookstoves

In a project report to the French environmental group A.D.E.M.E., scientist, Robert Chiron describes the project funded by his organization.



"A novel methodology developed by David and Ruth Whitfield was tested<sup>26</sup>. Efficient wood stoves, retained heat principles and solar cookers would be the "hard" part of the appropriate technology. The "soft" part, the ideas - were transmitted to participants through a week's hands on

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work shop blended with a substantial follow up period to "baby sit" the transformation while new cooking and use habits were formed." As is explained in the report, that approach has been constantly modified to incorporate the lessons learned through the experiences acquired by the executors of the project from 2000 to early 2003. Nearly 1,000 cookers built, 800 persons trained and solid scientific data validate the effectiveness of the approach and methodology utilized in this project.

Participants were surveyed before the course, then every 2 months during their 6-month follow up training. Those results help document

the ability of ecological cookers, such as solar cookers, highly efficient in terms of reduced greenhouse gas emissions to participate within the framework of clean development, demonstrating their effectiveness in measurable terms.

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The project proves that solar cookers can be assimilated into Bolivian culture (and presumably other similar cultures). A 65% or better fuel savings is demonstrated, which translates to a CO2 reduction of about 900 kilograms per year per cooker.

Increased health, better nutrition and an overall higher quality of life are secondary benefits from their usage, which also affect sustainable development.

The project documents increased consumption of healthier food groups, water pasteurization and homemade boiled drinks, which implies better nutrition and better health.



Since it is known that cooking indoors with firewood damages women's health, the fact that firewood consumption decreased by 85% certainly equates with improved health for women and children.

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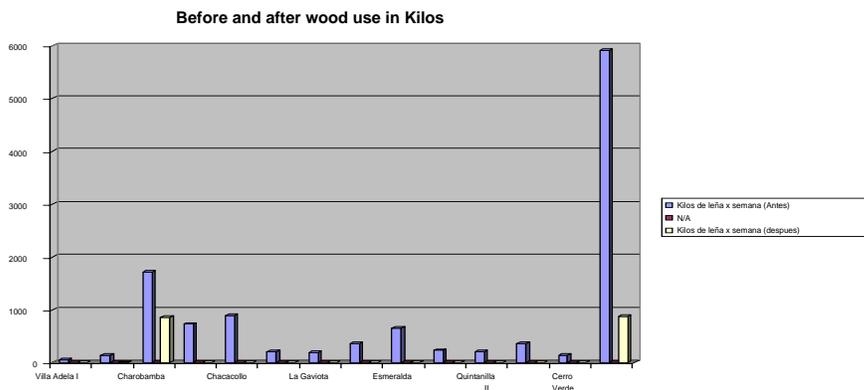
Recuperation of time spent controlling cooking and gathering firewood permit additional income generating activities. On a larger scale, this phenomenon could positively impact the GNP of developing countries around the world.

This investigation concludes that ecological cookers

(improved biomass cookstoves, retained heat cooking devices and solar cookers), significantly contribute to the reduction of greenhouse emissions in Bolivia. The verifiable results of an average fuel savings of 65% can be applied to any combustion source as a measurable indication of emission reduction, and this should be the basis for a clean development mechanism establishing relative value.

Certainly the methodology incorporated by the executors of the project contributed to the impressive results established through this study.

This study clearly recognized that diffusion of the use of ecological cookers is a concrete approach to certifiable clean development.



Notice the dramatic difference between the kilos of firewood burned before the course (5,911 kilos) and the small amount burned after the course (875!). That means an 85% decrease in firewood consumption!

The survey documents that when the courses started, wood was recovered a total of 195 times per week amongst the 373 respondents compared to only 31 times at the end of the courses.

It is worth noting that 39% of the participants (144) used firewood at the beginning of the course while only 8% (31 people) used wood afterwards.

The report to A.D.E.M.E. concludes that solar cookers can be assimilated into the Bolivian culture, resulting in a High usage rate.

- 97% of those surveyed used the solar cookers 3 times or more a week.
- 89% use the cookers 5 to 7 days a week. (In 2001 77% were in this category)
- 46% use the cookers 7 days a week.
- 81% used the solar cookers to prepare 2 or more meals a day.
- 14% cooked 3 meals a day in the solar cookers.
- 95% heated water for washing dishes or bathing in their solar cooker.
- 54% pasteurized water in their alternative cooking devices.
- The participants developed a significant variety of uses for the solar cookers.
- These uses were disseminated to others through participation in the follow up meetings (every 15 days during the six months).
- The course results validate the methodology utilized throughout the course.

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The information gathered during the reporting period of June 2002 through April of 2003 demonstrates interesting patterns of ecological cooker usage. The instrument (How many days do you use the solar cooker?), illustrates increased usage from the start of the

participant's cooking, through the end of the 6-month period. Actually, from the beginning, 97% of those surveyed reported using the cookers 3 or more times a week. However comparing those using the cookers from

5 to 7 days a week at the beginning of the reporting period (54%), with those using the cookers 5 to 7 days at the end of the 6 months (89%), one is astonished to find an increase of 35%. This seems to indicate user acceptance and an evolution as ecological cooking is assimilated into their culture. It should be noted that the quantity of those using the cookers fully 7 days a week increased by 14% (from 32% of those surveyed to 46%), during the reporting period.

Another indication of regularity of use would be an analysis of which meals are prepared with the solar cookers.

In the surveys, the participants were asked, "What meals do you prepare daily in your solar cooker?"

Their responses give evidence that a significant portion of those participating used the cookers to prepare both lunch and dinner (26% at the start of the course, increasing to 56% at the end of the 6 months). While those preparing only lunch at the beginning amounted to 46%, that percentage dropped to 22%. A full 81% of those surveyed used the solar cookers to prepare 2 or more meals per day. Within that group, it is worth noting that between 13 and 14 % of those participating used the cooker for 3 meals a day!



An other important indicator of regularity could be derived from observing the additional uses the new solar cooks developed for these alternative-cooking devices. The caliber of training received by the participants is demonstrated by the variety of uses reported.

Water heating (95%), and water pasteurization (54%) are overwhelmingly cited as additional ways in which the solar cookers are utilized.

Actually, conserving fruits, making homemade refreshments, cakes, mote (dried corn slow cooked in water until it bursts open), and even laundering clothes are worth mentioning. One person reported melting tar to fix a roof in her solar cooker. Several participants cooked dog food in their solar cookers.

The 26,992.59 US\$ per year before course fuel cost of those surveyed less

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an after course cost of 9,353.19 US\$ translates into **an economical savings of 17,639.40 US\$ per year which is a 65% reduction**. This equals an average savings per participant of 49.13 US\$ annually.

Before this course the participants averaged 2.02 hrs controlling lunch and 1.45 hrs controlling dinner for a total of 3.47 hrs daily per person/ weekly 24.29 hrs. That could mean 1,267 hrs a year. **That amounts to about 53 days per year per person spent controlling the food cooking.** However after the course these same participants only spent 0.92 hrs

controlling lunch and 0.88 hrs controlling supper for a new daily average of 1.8 hrs or weekly only about 12.6 hrs total. That means that **the participants recuperated about 11.7 hrs per week that could be potentially devoted to productive activities.**

The results of solar cooker usage in this project are significantly greater than previous projects in other parts of the world, for example in South Africa 38% overall usage has been reported. As stated earlier, increased health, better nutrition and an overall higher quality of life are important benefits from ecological cooker usage, which also affects sustainable development.

One of the positive elements of the methodology is the replicability of this technology.

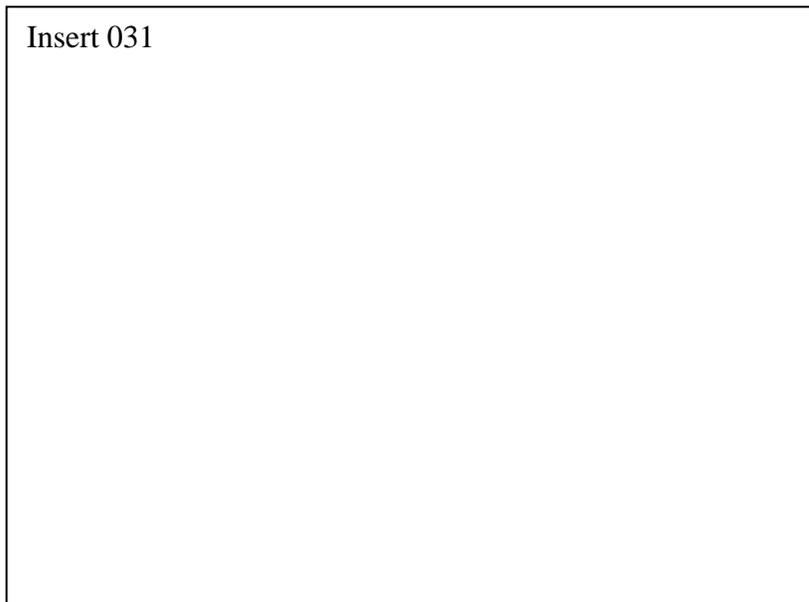
In most cases, the devices are built using low cost, locally available materials and unskilled labor. The theory is explained using terms and examples common to each target group's reality.

The foods prepared during the courses are those normally used in the different climate zones and customs.

Generally the local participants are required to recapitulate the information taught in their own terminology.

After being taught the methodology in 2001, a Peruvian was able to execute 6 courses himself in southern Peru. This year they expect to build 200 cookers. French technicians have been taught in Bolivia and then they have taught African and French NGO personnel in France how to use the methodology. Last year 5 Bolivians were awarded certificates of achievement based on their abilities to teach the methodology. This year they will be running courses on their own.

The didactical materials can be revised for any language. Most developing countries are located in climates conducive to ecological cooker use.



The methodology stresses fomenting problem solving and decision-making abilities in the participants and builds on progressive small victories.

The body of knowledge acquired related to the dissemination of ecological cooker technology in Bolivia and Southern Peru

between 2000 and 2003 is based on the following reporting and measuring methodology:

There was 953 solar cookers built in the following sequence –

- 2000: 77 cookers,
- 2001: 267 in Bolivia y Peru,
- 2002: 609 cookers (404 built by participants in Bolivia; 100 cookers fabricated semiprofessionally and given already made, and 105 cookers in Peru utilizing the Sobre la Roca methodology).

A total of 32 courses were executed in Bolivia in three distinct demographic areas, URBAN, PERIURBAN and RURAL. These courses had the following distribution characteristic –

- URBAN - 29% of the courses and 22% of the cookers
- PERIURBAN – 35% of the courses and 38% of the cookers
- RURAL - 36% of the courses and 40% of the cookers.

A total of 8 courses were executed in Southern Peru

- PERIURBAN – 39% of the courses and 45% of the cookers
- RURAL - 61% of the courses and 55% of the cookers.

The following instruments were utilized to gather, develop and understand data:

- A 6 - month Voluntary Contractual Agreement.
- Weekly Cooking Sheets (26 per participant).
- The Participant Survey (taken before each course and at 2 month intervals for 6 months).
- The General Coordinator's Monthly Report
- The Local Coordinator's Monthly Report
- Monthly Meeting Assistance Register for each group
- Monthly Fuel Savings Register for each group
- Monthly Payment Register for each group
- Certificate of Achievement and Ownership awarded at completion of contract.
- Tape recordings of individual interviews
- Video recordings of course activity and interviews
- Photographs of activities
- Various excel programs were developed to collate and analyze data

There were approximately 19,000 Weekly Cooking Sheets developed, of which approximately 9,000 were used to verify data and compare with data recorded in the other instruments. These instruments were pictorial sheets registering the food groups, cooking time, climate data and user satisfaction. It was not necessary to be able to read to use the sheets.

#### **4. Lessons learned**

Numerous studies clearly demonstrate a direct relationship between traditional cooking practices, and proven health problems such as respiratory ailments, cataracts, monoxidie in bloodstream of pregnant women, lung cancer, burns, impure water, lack of nutrition because of lack

of fuel, labor burden on women and children looking for fuel and breathing particles in polluted indoor air.

Acute respiratory illness (ARI) is the number one killer of children under 5 years of age in Central America. Burns from cooking fires are the fourth largest agent of death among South African teenagers

For hundreds of millions of people, income spent on fuel reduces buying power for food, affecting nutrition and general well being.

Death and disability is the result of permitting traditional cooking practices to continue.

The World's people have united under one banner in the form of agreeing to certain minimum levels of life, established as the Millennium Goals. Improved cookstove programs significantly contribute to the obtainment of these goals.

- Eradicate extreme poverty and hunger**
- Achieve universal primary education**
- Reduce child mortality**
- Promote gender equality and empower women**
- Improve maternal health**
- Combat HIV/AIDS, malaria, and other diseases**
- Ensure environmental sustainability**
- Develop a global partnership for development**

Improved cook stoves alleviate serious problems in **HEALTH, ENVIRONMENT, ECONOMICS, as well as ADD VALUE TO THE LIVES OF WOMEN and CHILDREN** in the developing world.

Improved cookstoves are devices varying from chimneys with hoods to extract smoke, to sophisticated parabolic solar cookers. Scientists, social workers and entrepreneurs have advanced this technology to a point that there are many models ready for mass dissemination. It has been demonstrated that methodologies have evolved facilitating the acceptance of these devices in developing populations, incorporating them into their culture.

Improved cookstove programs are the most important and necessary energy delivery system available. To have healthy air and enough fuel to cook with is more vital than electricity.

I have heard it said that the rate of return for the investment in alternative cooking devices does not justify the investment. The above facts provoke me to disagree.

Decision makers must recognize their complicity in perpetuating this problem if immediate actions are not taken to change intervention policies.

## 5.0 What Actions Are Needed Now?

- Priority must be given to eradicating indoor air pollution through improved cooking devices and fuels.
- There is a need for planners, governmental agencies, donor agencies and NGOs to reevaluate the relevance of household energy, putting emphasis on alternative cooking devices.
- Solutions must be found through an integral approach involving energy, education, financial (micro-credits) and health policy makers.
- Holistic interventions incorporating improved biomass devices, heat retention devices and solar cooking should be implemented.
- Governments should educate their policy makers concerning the dangers of indoor air pollution.
- Calculations for rates of return for investment should take into consideration the cost of illness and early death on the GNP of nations.
- More activities promoting networking and sharing of experiences are needed.
- Citizens should be educated about the negative effects of indoor pollution and encouraged to implement alternative interventions.
- Funds programmed for other energy related delivery systems should be reprogrammed to give priority to rapidly alleviating the indoor air pollution crisis.

What other actions can you think of?

Alternative cooking technologies **are** the most important tools we have to reduce human suffering and relieve environmental degradation.

**Better health**

**Better Nutrition**  
**More productive time**  
**Reduced desertification**  
**Considerable fuel savings**  
**Reduced greenhouse emissions**  
**Great rate of return for your investment = Quality of life.**

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<sup>1</sup> **Darwin Curtis**, President of Solar Household Energy, a non profit organization dedicated to dissemination of alternative technologies through entrepreneurs; extracted from an email communication with the author, 05/23/2003 - <http://www.she-inc.org/>

<sup>2</sup> **BALANCING THE SCALES** <http://solarcooking.org/balance.htm>;  
[http://www.who.int/environmental\\_information/Women/womfuel.htm](http://www.who.int/environmental_information/Women/womfuel.htm);  
<http://solarcooking.org/cookingsmoke.htm>

<sup>3</sup> ETHOS organization, Proleña, Nicaragua

<sup>4</sup> **Dr. MR. R. Panadey**, HEALTH EFFECTS OF INDOOR AIR POLLUTION, Glow Magazine, February 2003, Vol. 29, pages 5 – 7. Published by the ASIA REGIONAL COOKSTOVE PROGRAM.

<sup>5</sup> **Imelda D. Soriano, Md, Mch, Rodolfo J. Soriano Jr. Md, Mph**, INDOOR AIR POLLUTION AND TUBERCULOSIS: A RETROSPECTIVE STUDY, Glow, Vol. 29, pages 14-18.

<sup>6</sup> **Auke Koopmans**, BIOMASS ENERGY, INDOOR AIR POLLUTION AND HEALTH, Glow, Vol. 29, pages 3 - 4.

<sup>7</sup> **PROF. S.K. Sharm**, Director of the Energy Research Center and Honorary Dean of the Chemical Engineering College of Punjab University; **IMPROVED SOLID BIOMASS BURNING COOKSTOVES, A DEVELOPMENT MANUAL**. Published by The Regional Wood Energy Development Programme in Asia - GCP/RAS/154/NET – Field Document No. 44 (pdf), September 1993, email- [rwedp@Fao.org](mailto:rwedp@Fao.org)

<sup>8</sup> **WHO, World Health Report: Reducing Risk, Promoting Healthy Life; WHO, Geneva, Switzerland, 2002.**

<sup>9</sup> **Ashok J. Gadgil**, TO DRINK WITHOUT RISK, Berkley California, February 1995, [ajgadgil@lbl.gov](mailto:ajgadgil@lbl.gov)

<sup>10</sup> **Dale Andreatta**, Ph. D., P. E., A SUMMARY OF WATER PASTURIZATION TECHNIQUES, <http://www.accessone.com/~sbcn/solarwat.htm>

<sup>11</sup> <http://www.fni.com/%7edononeal/Safety.htm>,

<sup>12</sup> An Anthology of Women, Health and Environment: Domestic Fuel Shortage and Indoor Air Pollution. From [www.who.int/environmental\\_information/Women/womfuel.htm](http://www.who.int/environmental_information/Women/womfuel.htm)

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- <sup>13</sup> **Anita Khuller**, Program Officer Winrock International India, IMPROVED COOKSTOVES DISSEMINATION: LESSONS FROM THREE STATES; Email: [akhuller@winrockindia.org](mailto:akhuller@winrockindia.org) Web: [www.winrockindia.org/www.renewingindia.org](http://www.winrockindia.org/www.renewingindia.org)
- <sup>14</sup> **Hellen Owala**, Development and Marketing of Rural Domestic Stoves in West Kenya. From an email communication – 6/25/2003 - [itkisumu@africaonline.co.ke](mailto:itkisumu@africaonline.co.ke)
- <sup>15</sup> **Swedi Elongo**, CADIC [cadic@cbinf.com](mailto:cadic@cbinf.com)
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- <sup>21</sup> **Dean Still**, Aprovecho Institute; [dstill@epud.net](mailto:dstill@epud.net)
- <sup>22</sup> **Stuart Conway**, [www.treeswaterpeople.org](http://www.treeswaterpeople.org)
- <sup>23</sup> **Pat Manley**, Masons on a Mission, [jmanley@midcoast.com](mailto:jmanley@midcoast.com)
- <sup>24</sup> Helps International, <http://www.fni.com/%7edononeal/>
- <sup>25</sup> **Michael Port**, [sos@solarovens.org](mailto:sos@solarovens.org)
- <sup>26</sup> **David and Ruth Whitfield**, Sobre la Roca: Energía Solar para el Desarrollo are the originators and developers of this methodology. <http://www.solarcooking.org/media/broadcast/whitfield/bio-whitfield.htm>

#### Some important links

<http://www.repp.org/discussiongroups/resources/stoves/> - Biomass cooking Stoves  
[www.solarcooking.org](http://www.solarcooking.org)

Gasnet <http://www.gasnet.uk.net>

DTU: <http://bgg.mek.dtu.dk/research/twostage/>

Biomass Engineering: <http://biomass-uk.com>

Stirling: [http://bgg.mek.dtu.dk/publications/pdf/amst02\\_v2\\_99.pdf](http://bgg.mek.dtu.dk/publications/pdf/amst02_v2_99.pdf)

<http://ecoharmony.net/hedon>

<http://www.efn.org/~apro/attitlepage.html>