# Potential Effects of Improved Cookstove Use and Barriers to Acceptance: A Case Study Measkron, Tanzania

**by**

**Michelle Setsu Holmes**

**A Thesis: Essay of Distinction**
**Submitted in partial fulfillment of the requirements**
**for the degree Master of Environmental Studies**
**The Evergreen State College Olympia**

**February 2010**

This Thesis for the Master of Environmental Studies Degree

by

Michelle Setsu Holmes

has been approved for

The Evergreen State College

by

_____

Peter Dorman
Member of the Faculty

_____

Linda Moon Stumpff
Member of the Faculty

_____

Bariki Kaale
United Nations Development Programme

_____

Date

## ABSTRACT

### Potential Effects of Improved Cookstove Use and Barriers to Acceptance: A Case Study, Measkron, Tanzania

**Michelle Setsu Holmes**

Out of dire necessity, nearly three-billion people on earth continue the long enduring tradition of cooking over an open fire. In Tanzania, East Africa the majority of the population is entirely dependent on fuelwood for household energy. Excessive use of forest resources contributes to deforestation which results in detrimental impacts on local subsitence populations. Limited financial resources restrict these households from using alternative cooking methods less dependent on forest resources. Improved cookstoves were specifically designed as a form of intermediate technology offering an attainable and inexpensive alternative to traditional cooking with three-stones, thus reducing dependence on forest resources. Based on research conducted in Measkron, Tanzania this thesis examines the implementation, technical performance, and effectiveness of improved cookstoves and barriers to their broader acceptance. Findings derived from quantitative and qualitative data suggest that successful implementation strategies for improved cookstove projects include use of local materials, community participation, education and training. In living conditions where few amenities exist, improved cookstoves are better promoted as a supplemental cooking method than a replacement to the traditional three-stones. This allows households to maintain the beneficial aspects of traditional cooking when needed: ambient heat, light and versatility. Because of the adoption of improved cookstoves, participants claimed to experience a fifty-percent reduction in fuelwood consumption. Calculations reveal potential fuelwood consumption avoided by the implementation of improved cookstoves for communities bordering the Hanang Forest Reserve suggesting that increased use of stoves can potentially reduce overall fuelwood consumption and deforestation. Determining the significance of this reduction requires further studies that examine both the rebound effect as well as other factors contributing to deforestation on Hanang Forest Reserve: illegal timber collection and charcoal making. Considering the broad satisfaction and benefits experienced by improved cookstoves users, pertinent justification exists to continue the endorsement of improved cookstove programs in communities dependent on forest resources for household energy.

Table of Contents

List of Tables



List of Exhibits

## Abbreviations

FAO - Food and Agriculture Organization of the United States

GBV – Gender Based Violence

GDP – Gross Domestic Product

IDP – Internally Displaced Person

PCV – Peace Corps Volunteer

RC – Regional Commissioner

TSH – Tanzanian Shillings

**Acknowledgements**

This thesis is dedicated to my Father who passed away on April 22, 2009 and to the people of Measkron, Tanzania.

To my readers: Dr. Peter Dorman, Dr. Linda Moon Stumpff and Mr. Bariki Kaale thank you for the superior guidance. To Karen Gaul, thank you for your assistance with the Evergreen Dream Grant which partially funded my fieldwork. Many gracious thanks to my dear friends and all of those who generously donated to The Tanzanian Stove Project, which also funded my fieldwork. And lastly, to my family and Dan, thank you for the endless encouragement.

## Introduction

We have relied on forest resources for energy, food and protection since the beginning of our existence. For many subsistence populations in the Global South the subsistence way of life today, including cooking with wood and fetching water from direct sources is indistinguishable from ancient practices. For individuals who live in developed countries with basic amenities available at the flick of a switch, cooking on a fire may seem primitive and inconceivable; yet half of humanity uses this method of cooking everyday. Presently, nearly half of the world's wood supply is used as energy for rural populations of the Global South (Shahpar, 2004). Throughout sub-Saharan Africa, 90 % of the population depends on fuelwood to cook meals (Ministry of Natural Resources and Tourism, 2000).

## Chapter 1: Dependence on Forest Resources

Due in part to poor infrastructure and lack of financial resources, subsistence populations in the Global South have limited access to alternatives to meet basic needs of survival, such as fuelwood. Continuous demands placed on forest resources by growing populations, without replenishment, leads to deforestation. Deforestation seriously alters and makes sometimes-permanent changes to landscape that reduce ecosystem services (Hosier, 1988). In cases where human populations are dependent on forest resources for their fundamental needs, deforestation is a great problem with potentially catastrophic consequences. As Jared Diamond (2005) illustrates in "Collapse," throughout history there have been many examples of entire civilizations collapsing due to deforestation, proving the essential dependence humans have on forest resources and justifying a need for immediate concern.

In sub-Saharan Africa, deforestation is occurring at staggering rates. From 1970-1994,

consumption of forest resources nearly doubled with estimated rate increases from 250 to 502 million cubic meters (UNEP, 2000). From 1990-2005, Tanzania specifically lost 37% of its forest and woodland habitat. In 2005, the Food and Agriculture Organization of the United States (FAO) estimated that Tanzania was losing forest cover at a rate of 421,145 hectares (170,504 acres) per annum. Tanzanian's Ministry of Natural Resources and Tourism (2001) calculated the rate of deforestation to be occurring at a rate of roughly 128,000-494,200 hectares (322,000- 1,235,500 acres) per year. Tanzania's total forest area is currently 35,257,000 hectares (8,708,479 acres) (Mongabay, 2005).

Forests are storehouses for every human need for subsistence populations throughout sub-Saharan Africa; therefore, environmental implications of deforestation are inextricably linked to social consequences. Over-use of forest resources in Eritrea, Ethiopia and Somalia have led to severe deforestation resulting in famines and losses to economic development. More recently, diminishing forest resources and harsh land degradation have been a contributing factor to tragic genocide in Sudan. Further complications result from fuelwood scarcity on Sudanese refugee camps where females, who leave the refugee camp to gather wood, experience gender-based violence (GBV), in the form of attacks and/or rape (Lynch, 2002).

## Chapter 2: Deforestation

The causes of deforestation in Tanzania are three-fold: environmental, social and economic. Commonly identified underlying driving forces are poverty, population dynamics, loss of traditional knowledge of forest management, weak institutions, lack of monitoring and enforcement, lack of financial and social capital, gaps between policy and practice, corruption, securing land tenure and international trade (Darama 2007; Elgard 2007; MNRT 2000).

Environmental causes of deforestation, in some cases, are inevitable results of weather and stochastic events. Climate change, fires, storms, flooding, volcanoes, extended droughts, earthquakes, wildlife and insect infestations, are examples of natural occurrences that have effected Tanzania (Groom, 2006).

The proximate social causes of deforestation include: agricultural expansion, wood extraction and infrastructure expansion, livestock grazing, fire, charcoal production, refugee resettlement and logging (Giest & Lambin, 2002; URT, 2007). As noted by Tanzania's Bureau of Statistics, 96.4 % of rural Tanzania homes are made from poles, branches and bricks derived from natural forests (Tanzanian National Bureau of Statistics, 2002). It is important to note that oftentimes removal of fuelwood from forest reserves takes place unlawfully (Government of Tanzania, 2008) in areas which are not policed for illegal harvesting.

Due to a lack of electricity and the availability of fuelwood at no cost (in most cases), fuelwood is utilized in industrial practices such as brick building, pottery making, lime burning and the production of agricultural goods including tobacco, tea, fish, salt-drying and in the brewing of beer and other liquors (Sawe, 1995). A brief history of Tanzania also indicates cause of deforestation to be rooted in the colonial drive for economic development that led to considerable land clearing for cash crops and timber (Maddox, 2006). This agricultural growth, initiated by the German and British colonists, stimulated foreign trade on the global market and created the backbone of economic growth and development for Tanzania (Palmer, 1992). Although this was over a century ago, this foreign trade prevails today and is encouraged by the Tanzanian government as a hoped-for source of growth. Presently the economy of Tanzania is strongly dependent on agriculture, which accounts for nearly half of the gross domestic product (GDP), employing 80% of the workforce and 85% of the total exports (CIA World Factbook, 2007).

The above-mentioned causes of deforestation result in environmental and social consequences as well. In their writings of Tanzania, Mnzava (1983), Kaale (1983), Macarenhas and Nkonoki (1984) have all concluded that land degradation contributes to social and economic hardship. The cumulative impact of 39 million people dependent on daily fuelwood use (CIA, 2008) significantly impacts forest resources in Tanzania. Over the past decade, demand trends for fuelwood have exceeded the growing capacity of Tanzania's forests, further exacerbating the deforestation problem (Thaxton, 2007).

Population growth, land degradation and poverty are closely linked in rural communities of developing countries (Goldemberg, 2000). Tanzania's estimated current population is 38,264,513 (Government of Tanzania, 2008) with a growth rate of 2.1% (IndexMundi, 2008). As population growth increases, so too does the demand on common property resources, such as fuelwood, further contributing to deforestation; continued deforestation reduces the carrying capacity of the land and ecosystem services for present and future generations in Tanzania (Ajeam-Ragee, 2005).

Environmental consequences of deforestation lead to alterations in the following areas: precipitation and temperature modifications to local and global climates, landscape stabilization, increased wind erosion, soil depletion, gully formations, silt build up in rivers and reservoirs, a decrease in carbon sequestration, carbon emissions from burning and decomposition, and biodiversity losses effecting plant and wildlife species (Geist, 2002).

Due to lack of funding, knowledge, resources and a variable climate, few reforestation programs exist to replenish forest resources. In the Hanang District of Tanzania, women reported that fuelwood doubled in price over a two-year period from 2005 to 2007; small bundles of wood went from 300 Tanzanian shillings (TSH) to 600 TSH; larger bundles went from 500 to 1000 TSH. Most residents of Measkron Village, Hanang District are not able to afford other cooking options

and are therefore, dependent on fuelwood. Crop residues and dried animal dung are other biomass options for household energy, but as claimed by Kaale, in his report for The Tanzanian Ministry of Energy and Minerals, fuelwood will continue to be the dominant energy source through 2014 (Kaale, 2005).

## Chapter 3: Household Cooking Practices of Rural Tanzanians

Rural Tanzanian villages cook with the traditional method that consists of three-stones placed in a triangular formation, which holds a pot over the fire. The three-stone method has drawbacks resulting from the practical yet, inefficient design. Since the stones do not create a barrier, heat constantly escapes requiring constant fuel replenishment. Women and children, who are primarily responsible for gathering fuelwood, spend two to three days each week collecting and then carrying wood on their backs or heads. The cumulative effect of fuelwood collection by this substantial number of people destroys the forest resource base on which this population literally depends on for existence.

The complexity of finding solutions to the deforestation problem stems from the simple fact that the activities which cause deforestation are often essential means of human existence and economic development. Throughout sub-Saharan Africa, the deforestation dilemma is a complex site-specific problem which can be understood through interdisciplinary analysis of past and present land management that includes traditional values and cultural ways of knowing. As Hosier (1988) states: "land clearing for agriculture and energy sources is a necessary means of survival for rural populations in sub-Saharan Africa, as the case is for rural populations in many less developed countries."

The situation is not hopeless, however. An affordable energy saving alternative to the traditional method of cooking with three-stones is available. Improved cookstoves are a low cost energy efficient alternative to cooking with the three-stone method. Improved cookstoves were invented as appropriate technology to reduce fuelwood use and indoor air pollution in countries dependent on fuelwood for household energy. E.F. Schumacher introduced the term "appropriate technology" to refer to projects that are sensitive and attuned to local resource availability and requested by community members (Clark, 1989). In contrast to the traditional method with three-stones, improved cookstoves have walls that create a barrier concentrating the fire, while conserving heat and reducing fuelwood use.

The efficiency of improved cookstoves results in environmental, health and social benefits. Existing case studies have shown that improved cookstoves can reduce fuelwood consumption by over 50% (Gill, 1985; Haider, 2002; (Kammen, 1995; Manuel, 2003; Persha, 2002; TECA, 2006; Trust, 2009; TWP, 2006; Zein-Elabdin, 1997) despite the proven benefits, populations which benefit from this technology are limited.

The two objectives of this thesis are to determine the rate of reduction in fuelwood consumption obtained by the adoption of improved cookstoves compared to the traditional three-stone method and identify barriers to broader cookstove acceptance. The results have important implications for organizations interested in practical, simple measures to lessen deforestation in communities highly dependent on forest resources.

## Chapter 4: Literature Review and the Improved Cookstove Technology

Current research on improved cookstoves reveals that stoves prove to be an effective fuel saving method of cooking for households dependent on fuelwood; the challenge exists in encouraging individuals to use the improved cookstoves.

Improved cookstoves are a promising measure for sustainable and efficient use of fuelwood (Foundation, 2008; Kammen, 1995). The use of improved cookstoves significantly reduces high levels of harmful indoor air pollution which accounts for 1.6 million deaths annually in countries dependent on fuelwood for household energy (Rehfuess, Mehta, & Pruss-Ustun, 2006). Reduced indoor air pollution is a major benefit of improved cookstove use and therefore deserves mention. However, this thesis will focus on the fuelwood savings aspects of improved cookstove use. Due to the environmental, health and social benefits of improved cookstoves advocates believe that broader use of stoves needs to be made a priority in fuelwood dependent communities (Foundation, 2008).

Acceptance of stove use varies in communities dependent on fuelwood as a primary household fuel source. Communities resist adoption of improved cookstoves for cultural and technical reasons (Gill, 1985) not obvious to promoters of improved cookstoves: lack of comfort and heat, cost, construction and maintenance, time, and energy. For some communities, saving fuelwood is not a priority and does not arouse interest in a new cooking method (Gill, 1985). In addition, marketing strategies play an influential role in acceptance levels for stove projects.

Poorly planned marketing strategies overlook the influence and significance of time honored cooking practices (Kammen, 1995) and delicate strategies necessary to alter tradition. A flawed strategy promoted by the World Bank and other organizations is to encourage stoves as a replacement, rather than an alternative, to traditional cooking methods (Ergeneman, 2003; Haider,

2002; Manuel, 2003; Mission, 2006). This forced change creates pressure on users while neglecting to respect the benefits received from cooking with three-stones.

In other scenarios improved cookstove promoters focus on mass production projects which result in impractical stove designs, with little fuel saving benefits (Haider, 2002). Early stove models from the 1970's were designed and tested in laboratories far removed from the user settings and were no more efficient than cooking with three-stones (Ezzati & Kammen, 2002; Gill, 1985; Jagadish, 2004). Impractical stove designs have caused 50-60% of stoves from a project in India to go unused (Harding, 2003). In another case, the Indian government reached their target to distribute 1.9 million stoves, but the stoves distributed were not the specific designs preferred for use; stoves sat idle and women continued cooking with the traditional three-stone method (Ergeneman, 2003).

Another common reason for faulty improved cookstove projects is lack of education and training on stove purpose and use (Jagadish, 2004). In India and China where households were given stoves without explanation, stoves sat idle (Ergeneman, 2003). A similar situation occurred in an Internally Displaced Persons Camp (IDP) in Uganda where individuals had expressed interest in fuel efficient methods of cooking; improved cookstoves were disseminated but stove use training was minimal (Development, 2007). There was no initial demonstration of stove purpose and fuel saving strategies prior to dissemination which ultimately reduced rate of acceptance.

An obvious disadvantage of improved cookstoves is that they cost money (Ergeneman, 2003; Gill, 1985; Jagadish, 2004). Furthermore, cement stove models need to be rebuilt after 2-3 years of use, creating additional costs. In comparison, the three-stones can be obtained at no cost and are extremely durable. The economic situation of subsistence populations is such that they do

not see the long-term benefits for the short-term cost of the stove (Manuel, 2003). Women have little motivation to save money for a stove when their cooking needs are already being met. Money spent on a new stove is money that could be used for food, medicine, school supplies, and other needs with higher priority. Cost is a significant barrier to broader stove use, but distribution of subsidized or free stoves does not ensure use as discussed in the following paragraph.

As a means to increase dissemination of improved cookstoves, governments and organizations which support stove projects may offer subsidies to make stoves more affordable. Subsidies increase stove dissemination, but decrease the true worth of a stove (Haider, 2002) and do not ensure that stoves get used. Subsidies can be offered in partial or full depending on the project sponsors. Subsidized projects in India, and Tanzania resulted in stoves which sat idle or were used for other purposes such as stools (Ergeneman, 2003; Manuel, 2003; Mission, 2006; Schlesinger, 2008). Stove recipients in a Kenyan project didn't value the subsidized stoves simply because they were free: "Stoves given away for free were often perceived as worthless by the recipients (Manuel, 2003)." In Ergeneman's evaluation of a partially subsidized stove project in India, manufactures who received the subsidies focused on government requests not the stove user needs; this resulted in low efficiency stoves that went unused (Ergeneman, 2003).

## Chapter 5: The Traditional Three-stone Cooking Method

Improved cookstove projects fail because stoves are unable to compete with the tried and true traditional three-stone method. The traditional three-stone method is preferred to the stove for several reasons not so obvious to those unfamiliar with traditional cooking: ambient heat, cooking versatility and lighting. Supporters of improved cookstoves have the best intentions of reducing fuelwood consumption to improve the efficiency of traditional cooking and the

surrounding natural environment, but cooking with three-stones is affordable (Ergeneman, 2003) and has evolved to meet particular needs that stoves cannot replace (Gill, 1985).

The warmth, social network and ritual focus (Gill, 1985; Harding, 2003) created while sitting around a fire at night while meals are cooked is an irreplaceable feature of traditional cooking intimately linked to rural living. The fire creates a unique setting where families come together to share supper while enjoying the light and warmth of the fire (Haider, 2002). Improved cookstoves have walls that limit light exposure and ambient heat that are necessary to families living in mud and cement homes which often do not have insulation or electricity. Stoves contain heat and flames within the stove, emitting less ambient heat and light onto the faces of family members therefore reducing the feel of this special atmosphere (Beck, 2008). In Southern Tanzania households resisted improved cookstoves because they did not offer ambient heat in the same manner as the three-stones (Wallin, 2008); this same situation occurred in Guatemala, (Ergeneman, 2003).

Structural differences between cooking with three-stones and improved cookstoves create limitations for users who have grown accustomed to the enduring tradition of cooking with three-stones. In comparison to the three-stones, structural differences of improved cookstoves cause side effects that reduce household comfort levels for users who are accustomed to the simplicity and adaptability of cooking with three-stones (Gill, 1985). The size of the fire and the cooking pot are both constrained by the immobility of most stove designs. The Astra stove model is built into the home and cannot be moved (Jagadish, 2004). Other improved cookstoves are mobile, but some weigh 10-15lbs. and can only be moved with assistance creating a disadvantage for users. With three-stones, women can easily move their cooking location to reduce smoke and utilize the wind for the fire. Lastly, with three-stones users can easily adjust to cooking with

different food types and brewing beer in oil drums, cooking for growing and shrinking families (Gill, 1985) and group gatherings, where 10-gallon pots are used for cooking meals (Petersen, 2008).

The efficiency of improved cookstoves reduces fuelwood use while cooking, in turn reducing indoor air pollution from smoke. From a health perspective, decreasing indoor air pollution is beneficial (Ergeneman, 2003; Ezzati & Kammen, 2002; Program, 1999; Rehfuess et al., 2006; Trust, 2009) but further analysis among users show reduced indoor smoke levels to be a disadvantage; smoke and heat play crucial roles beneficial to households in the Global South (Development, 2007; Gill, 1985). The valuable use of smoke and heat in households is overlooked by government officials and development workers who do not live in mud homes and have no personal experience cooking with three-stones in conditions with limited amenities (Hiner, 2008). A reduction in indoor smoke is observed as an inconvenience for households that depend on smoke for the beneficial uses: ambient heat, light, insect deterrent, food preservation and the aroma and flavor in food (Gill, 1985; Haider, 2002; McConnell, 2008; Wallin, 2008).

Improved cookstove projects have been successful in cases where more realistic marketing strategies are adopted. Lessons learned from failed cookstove projects has led to culturally suitable marketing strategies focused on the communities targeted for stoves with an emphasis on appropriate technology themes (Cecelski, 2001; Ergeneman, 2003; Kammen, 1995). Stove project success is contingent upon adapting the project to local needs (Haider, 2002). Appropriate marketing strategies can be determined by intimate longitudinal studies of the habits of the recipient community (Haider, 2002).

Cultural acceptance of a new practice is more likely to be met when the behavior change is assimilated by the recipient culture rather than imposed by outsiders (Clark, 1989). The

introduction of a new object into any community requires a particular means of dissemination to encourage adoption; when this process is neglected so too is adaptation (Clark, 1989; Ergeneman, 2003). Promoters of improved cookstove projects are often from Western countries (Kammen, 1995) where marketing efforts are supported by television and electronic media which differs from marketing methods in communities targeted for stove projects.

Marketing strategies which follow Schumacher's rules for appropriate technology focus on the use of local materials to build stoves and goes hand in hand with effective education and training, fundamental to the success of any improved cookstove program. Local materials are used to encourage project success; if women need to travel far distances or pay high prices for materials, the project is less likely to succeed.

Failed stove projects resulting from lack of education and training are all too familiar. Trial and error has led to the realization that improved cookstoves are critically dependent on user input (Cecelski, 2001). Considering this finding, projects have learned the importance of collaboration with local women to increase widespread success (Gill, 1985; Haider, 2002). Tailoring stove designs to meet the needs of women using the stoves takes the emphasis off structural differences that were previously described as potential drawbacks. Failed projects are accompanied by project summaries stating that more education and training is recommended and more importantly, requested by the stove recipient community (Hamilton, 1984).

In contrast to top-down approaches, this grassroots bottom-up marketing strategy paves the way for women to directly experience an improved cookstove which ultimately contributes to project success (Haider, 2002; Persha, 2002). Involving women in intermediate forms of technology such as improved cookstoves creates opportunities for women to contribute their

highly sophisticated local knowledge in ways that improve their quality of life and reduce workload (Cecelski, 2001).

Here follows a case study conducted in Tanzania, East Africa by a graduate student from the Evergreen State College in Washington State. The author incorporated the knowledge gained from her two years working as an environmental volunteer in the community.

## Chapter 6: The Case Study Objectives and the Study Area

1) To determine rate of reduction in fuelwood consumption obtained by the use of improved cookstoves compared to a traditional three-stone method
2) To identify barriers to broader acceptance of improved cookstoves

### *Description of the Study Area*

The case study was conducted in Measkron Village of the Hanang District, Tanzania. The author resided in Measkron on two occasions: December 2003- November 2005 working as a United States Peace Corps Volunteer (PCV) and June 16 -August 31, 2007 while independently conducting research for this case study.

Measkron Village is located southwest of Arusha in the Hanang District of Tanzania, East Africa. Hanang District


Exhibit 1 www.cia.gov

was established in 1936 and is located in the north-central area of Tanzania, along the East African Rift Valley. As of the 2002 population census results Measkron's population was 10,002 and was composed of 1,697 households with an average family size of 5.9 (Tanzania Bureau of Census, 2002).

***Dependence on Forest Resources***

As of 2006, the main energy source was wood-based for 98.8% of households in the Hanang District; national average for wood-based energy in Tanzania is 95% (JAICA, 2006). Because of this unavoidable dependence, deforestation is a continuous threat and reported to be the most severe environmental problem for the Hanang District (Darema, 2007). Measkron is at the foothills of Mount Hanang bordering the forest reserve of roughly 5832 acres (Policy, 2007). Deforestation on the forest reserve is caused by several forces including various illegal activities such as fuelwood collection, charcoal making and timber harvesting (Mdundo, 2009).

The cumulative effect has exacerbated deforestation to 371-425 acres annually; 120 acres (30%) of this can be attributed to fuelwood collection (Mdundo, 2009). The impact of these changes is affecting the water supply for surrounding communities, including Measkron, which is dependent on this single water source. Women in Measkron, who collect their own fuelwood from the surrounding area, have claimed that local fuelwood supplies have diminished. The chore of fuelwood collection takes 1-2 hours longer now than it did ten years ago (Johnson, 2007). Fuelwood shortages have allowed some individuals to profit. Women, who carry firewood on their backs or heads from remote areas to sell, have raised their prices by 25-50% in Measkron and throughout the Hanang District.

Forest resources serve numerous other uses in daily life throughout Hanang District. These include: herding sticks, hoe handles, ax handles, knife handles, spoons, stirring spoons, building

materials, furniture, shade, beehives, bee fodder, medicines, water source protection, clean air, bring rains, paper, stop wind, soil erosion prevention, environmental protection, fruit, soil nutrients, fish poisoning, charcoal, cattle fence, farm fence, poison, snake medicine, toothbrushes, livestock fodder, thorns, perfume for export, sculpture, clothes irons and decoration (Petersen, 2008).

## Chapter 7: Background of Cooking Practices

In rural Tanzania, many of the daily practices such as farming and cooking are century old and passed on through generations of families through oral transmission. Verbal communication is the primary method of information exchange; few written records exist. Rural Tanzanians are not dependent on measuring cups to cook but instead depend on senses such as texture, feeling for consistency and smell. Although a woman may not use a measuring cup to cook corn porridge, her habits and ritual practice of this activity result in every batch of porridge tasting identical to the previous one, demonstrating consistency and repetitive cooking practices.

### *Traditional Three-Stone Method*

The traditional method of cooking consists of using three large stones placed in a triangular formation in such a way that a pot can be securely placed on top, in the center, for cooking (See exhibit 2). In most cases, the fire is started in the center of the three-stones with dry biomass such as leaves, grass or branches accompanied with larger sticks to hold a strong fire. After cooking begins, fuelwood is placed in the fire between the three-stones as needed to continue adding heat.

**Exhibit 2**

### *Improved Cookstove Technology*

The improved cookstove used in this case study is the jiko sanifu. In the Swahili, jiko translates to stove; sanifu means efficient. The author learned how to build this stove at the Primary Health Care Partners in Mchame, Tanzania. The stove consists of three parts sand, one part white wash, one-part cement and water; all materials are available in the nearest town Katesh. The stove is a 16x16 inch square box with a clay pot in the middle that serves as a fire bowl (See exhibit 3). A small opening 3x3 inches wide (or larger) creates an opening for wood. Three rounded pieces are molded ontop of the stove to elevate the pots while cooking. In most cases, the fire is started with dry biomass such as leaves, grass or branches. After cooking begins, fuelwood is placed in the fire bowl as needed to maintain the fire. The heat is sheltered by the barrier of the four walls of the stove, increasing cooking efficiency. In addition to wood, other biomass such as corncobs, corn stalks and dried dung can be burned inside this stove.

**Exhibit 3**

## Chapter 8: Research Methods

Community members from Measkron and surrounding areas frequently requested the stove project; this enthusiasm led to the conception and justification for this research project. The researcher created the case study from experiences of living in the community of Measkron for two years. In the initial planning stages, the researcher constructed a comparative design case

study focused on quantitative data collection. The primary goal of the case study was to compare fuelwood consumption of the two cooking methods on data collection sheets; the variable examined is fuelwood.

One month prior to the case study, the researcher recalled that the most common method of communication was through verbal means in Measkron. With this in mind, the researcher knew that qualitative data would be easily accessible for the data collection process. Qualitative data was collected in the form of opinions, semi-structured interviews, participant observation, and anecdotal data. For this reason, it was necessary to use a mixed methods approach coding the data in two ways: qualitative and quantitative. Mixed method approaches are applied in three stages of the case study: collection, analysis and interpretation.

Mixed methods research has become more widely accepted (Sale et. al, 2002) in the past few decades and is becoming known as the third major research paradigm (Johnson and Onwuegbusie, 2007). Mixed methods research is gaining popularity due to the effectiveness in presenting different levels of analysis, expanding the meaningfulness of findings and offering a more holistic representation of data (Rudestam and Newton, 2007; Creswell, 2008) strengthening and supporting research in general. Qualitative data tells a story and offers evidence in areas that quantitative data is not able to support. Furthermore, fuelwood consumption in rural Tanzania is a highly complex phenomenon, which requires numerous perspectives (Sale et. al, 2002) and evidence to increase understanding.

As Linda Smith discusses in Decolonizing Methodologies, the globalization of knowledge consistently points to knowledge from the West as supreme and civilized in comparison to others, which Smith regards as a flawed concept. It is impossible, but necessary, to remove one's own ethnocentric views when examining an unfamiliar community. The researcher focused on the

collection of specific data related to her project goals and her notion of what was important to improve livelihoods in rural Tanzania. In her pursuit of obtaining this knowledge, she devalued information revealed by participants that did not pertain to the project scope. Out of respect, the researcher later found it necessary to place value in this "other" knowledge outside the scope of her project. Due to the nature of rural Tanzanian culture and tradition, the researcher was often asked to stay for tea and lunch or dinner. Although initially reluctant to stay, these moments put the researcher in the place of the one in observation and allowed the researcher to experience events she would not have witnessed otherwise. Often times numerous questions were directed at the researcher from everyone present. In some cases, the researcher felt insulted, other times the researcher was not able to translate when the tribal language was spoken.

***Participants***

The Barbaig, a semi-nomadic Nilotic tribe who originated from the Rift Valley in Northern Tanzania, were the first known tribe in Measkron and the Hanang District; the Iraqw tribe followed the Barbaig. Due to their semi-nomadic preferences and their dislike of the Iraqw tribe, most Barbaig have moved out to more rural areas of the Hanang District. Due to the availability of land and water resources from Mount Hanang and nearby lakes, people from other tribes in neighboring district have settled in Measkron. Occasional disputes over theft arise among the Barbaig and Iraqw tribes in rural areas outside of Measkron. But for the most part, the community of Measkron is peaceful.

Group celebrations take place for weddings, funerals, elections, school celebrations and other community events. During these occasions, 20-gallon sized aluminum pots or 50-gallon drums are cut in half to cook food for many: 200-300 people. Food includes: rice, beans, corn porridge

and sometimes meat such as beef, chicken or pork. To support the large size of the pots, it is necessary to cook over a three-stone fire. In these situations, it would be impractical to use an improved cookstove.

The majority of the population in Measkron is composed of subsistence farmers. If the rains arrive on time and families receive a surplus crop of corn or beans, the excess may be sold to pay for household repairs, school fees and uniforms or livestock. During the years when the rains are late and crops fail, families lose this primary food source causing hardship for all.

***Implementation***

The Mayor of Measkron was the first to own an improved cookstove; a Peace Corps volunteer from a neighboring village built the stove in 2003. Because the Mayor was impressed by the stove, in a sense, her well-respected opinion initiated the stove into Measkron. This initiation significantly contributed to the overall acceptance of the stoves prior to this case study.

Participants spoke their tribal language, which was mainly Kiraqw spoken by the Iraqw tribe, Swahili and the occasional one or two words of English. Out of respect for the Tanzanian participants and to be sure information was not lost in translation, research was conducted in the national language Swahili. Swahili is the mother tongue of Bantu people living on Zanzibar and Tanzania. Swahili is also spoken in Kenya, Uganda and the Islands of Zanzibar and Pemba. With origins as a language of trade, which linked the inland Bantu-speaking populations with the Indian and Arab-speaking population of the coast, Swahili is Bantu in structure and form, but its vocabulary draws on a variety of sources including Arabic and English (Petersen, 2008).

A purposive sample was necessary for two reasons: first, participants had to be cooking with the traditional method and second, participants would later cook with the improved cookstove. A non-random convenience sample of 26 women from Measkron Village were qualified them to participate in this case study because they showed interest in owning an improved cookstove. The cohort of women lived in clusters within a one-mile radius of the author. If a participant was away from their home, the author could easily return later in the day. Participants were often away from their home harvesting crops during July and August so proximity served as a great advantage to the author. The 26 participants and most other women in Measkron had little money for more costly cooking alternatives such as charcoal and kerosene.

Ten women from the cohort were selected for the sub-group who committed to record fuelwood use and cooking times for a one month period. The author explained that by recording fuelwood use and cooking times, it would be possible to make comparisons to the three-stone method. It was also explained that the stoves were meant to help reduce fuelwood use (ultimately) deforestation and indoor smoke pollution. The cookstoves were not promoted as replacements to the three-stone method, but merely as an alternative and supplemental cooking method. The women were not asked to discontinue using their three-stones for cooking but to simply try out another method of cooking.

In the initial phase, the sub-group recorded cooking times on the traditional three-stone method for two weeks. During that time, the author built a cookstove together with the participant and anyone else interested so that others would have the opportunity to learn. In the second phase, the participant would begin recording data about their new stove. Each woman was provided a watch, a pen and a sheet of paper with a chart to record fuelwood use and cooking times. The data chart

included columns for the following: Cooking Start Time, Cooking Finish Time, Food Type, Pot Size, and Quantity of Wood Used (Table 1).

| Food Type | Pot Size | Start Time | End Time | Quantity of Wood |
|---|---|---|---|---|

**Table 1**

As part of this case study in 2007, over half the cost of the stove was subsidized for ten women who were then required to pay 1500 TSH (estimated $1.50) and participate in the construction of their stove. Previously in 2005 when the author first promoted the stoves, half of the cost of each stove was subsidized through a grant; 12 women paid 1500 TSH and participated in the construction of their stove. After two months, the grant money diminished and the author was forced to raise the price of the stoves to cover full costs. At full cost, surprisingly, 16 households purchased stoves at 3000 TSH (estimated $3.00). In 80% of these households, both the husband and wife worked which contributed to higher household incomes and may be one reason why they were able to afford a stove. These households were not required to participate in the construction of their stoves. Furthermore, the husbands and wives worked and were not usually available during daylight hours to make their stove; electricity was available in few households. Lastly, by chance, the author and her partner met a local craftsman in the nearby town, Katesh. The craftsman, Kizito Mwati, also knew how to build improved cookstoves but did not have funding to continue this work. In order to meet fundraising goals, the author collaborated with Kizito by giving him three micro loans. In collaboration with the author, Kizito built and sold 44 stoves. During this time, the cost of gas increased on three occasions. In response, shop owners also raised the price of cement three times. To cover costs and make a small profit, stoves were sold for 7000 TSH (small stove) and 8000 TSH (larger stove). The income demographics of the

women and men living in Katesh made it possible for them to purchase stoves at this cost (Mwati, 2007).

Having lived in the community for an extended time, the author felt that it was feasible and necessary to subsidize half the cost of the stove to increase dissemination and encourage participation during the short duration of this case study. Because of the concern that little or no value would be placed on ownership of the stoves if stoves were fully subsidized, the author opted not to fully subsidize the stoves.

A recent update on Measkron Village from a neighboring PCV, Stephanie, informs that a total of 50 stoves have been built since the case study was conducted in 2007 (Erckle, 2009). Five stoves were built with a health volunteer in Measkron; these stoves were sold for 8000 TSH. In a nearby village, Bussoutoghang, Kizito gave a stove-building workshop. The participants had recently suffered hardship from, severe droughts which caused their bean and corn crops to fail. Because of these unfortunate circumstances, the farmers had little food for their families and small profits, if any, from their harvests. As a result, Stephanie claimed that the women priced the 22 stoves they made at the workshop at cost for 6000 TSH.

## Chapter 9: Project Monitoring and Evaluation

Project monitoring and evaluation was conducted through open-ended interviews and surveys. The author made follow-up visits to stove users on a weekly basis. Semi-structured interviews-followed a set of questions (listed below) for guidance giving participants room to reveal what they felt was important. The author found it more effective to interpose interview questions into general conversations, which effectively increased dialogue.

Survey Questions
JIKO= improved cookstove

1. How many times a week do you collect wood? (three-stones)
2. How many times a week do you collect wood? (cookstove)
3. Which method of cooking do you prefer and why?
4. Was it hard to get used to using the JIKO?
5. Does the JIKO cook faster?
6. Do you boil your drinking water with the JIKO? More often than before?
7. Do you cook more meals with the JIKO?
8. Is there less smoke with the JIKO?
9. If YES, Do you cough less from the cooking smoke or feel like your health is better?
10. Does the JIKO use more or less wood? How much?
11. Will you be able to save money to make another one? (cost 3000 Tanzanian Shillings= $3.00)

*Chart Comparison Key Features of the Improved Cookstoves*

| Three-Stones | Improved Cookstove |
|---|---|
| Excessive fuelwood consumption | Reduces fuelwood consumption by 50% |
| Creates harmful indoor smoke pollution | Reduces indoor smoke pollution |
| Open Fire | Safer Enclosed Fire |
| Meals take a long time to cook | Cooks meals faster |
| No Cost | Cost |
| Food Preservation | |
| Insect Deterrent | |

**Table 2**

## Chapter 10: Significant Findings

In hopes to present data through statistical analysis, every effort was made to obtain high quality data. Due to factors beyond the control of the author (see limitations) this was not possible. The findings reflect upon the daily cooking practices and fuelwood consumption of participants. The cumulative impacts of these daily practices make immeasurable contributions to the livelihoods and surrounding environment for the community of Measkron. Although narrow in

scope, the following findings offer valuable results that had great impact in the daily practices of the participants and for this reason they deserve mention.

***Fuelwood consumption***

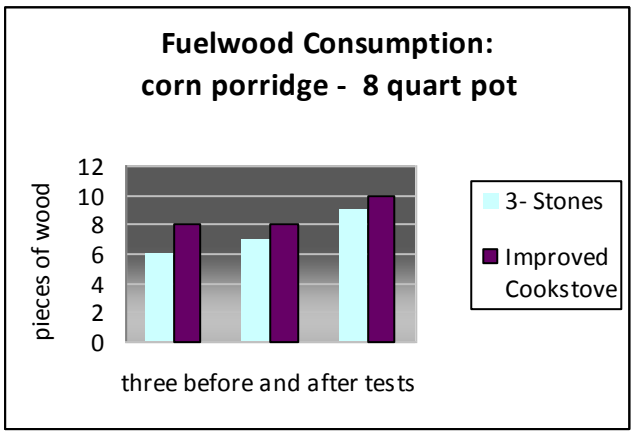


**Exhibit 4: Six observations (Holmes, 2007)**

The first valuable finding uncovered by this case study from six observations (Exhibit 4) is that the improved cookstoves did not consume less fuelwood for cooking on a consistent basis. The above quantitative data chart was compiled from participants in the sub-group. The first comparison examines fuelwood consumption when cooking corn porridge with each method. Mama Freddie cooked corn porridge under six separate instances using Grevillea trees for her fuelwood source. The finding shows that in each of the three comparisons, the three-stones actually consumed less fuelwood than the improved cookstove.

Qualitative data supports this finding with surveys that reveal 18% of the women reported to prefer cooking corn porridge with the three-stones instead of the improved cookstove. Participant observation adds to the mentioned findings. Although they did not report it when asked, three additional women were observed using the three-stones instead of the stoves to cook corn porridge.

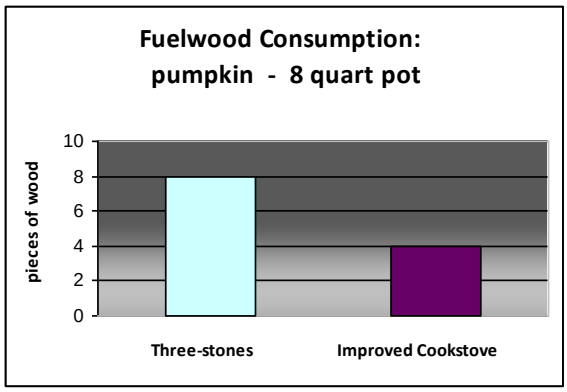


**Exhibit 5: Two observations (Holmes, 2007)**

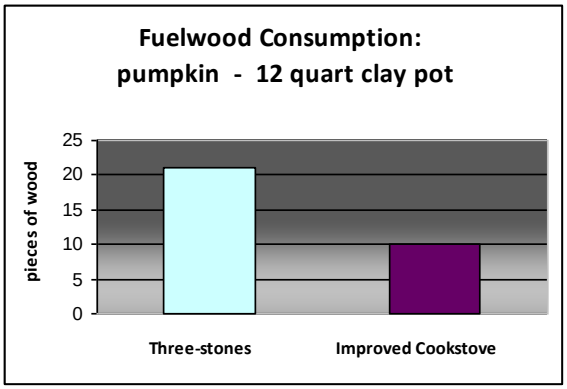


**Exhibit 6: Two observations (Holmes, 2007)**

Next, a comparison of fuelwood use is made for two popular meals: pumpkin and beans mixed with corn. Above, Exhibit 5 and 6 compare fuelwood consumption (Grevillea wood) for pumpkin. Figures show that the three-stone method consumes twice the amount of fuelwood as the improved cookstoves.

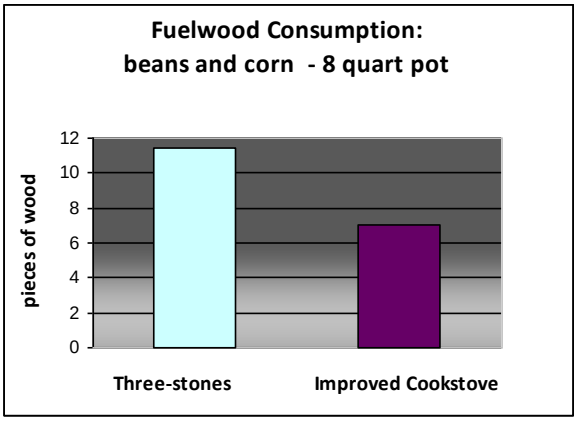


**Exhibit 7: Two observations (Holmes, 2007)**

The cooking comparison for beans and corn in exhibit 7 show again, that the three-stones use nearly twice as much (Grivillea) fuelwood as the stoves. Results from both exhibits above are supported by unanimous claims extracted from qualitative data. The entire cohort was highly satisfied with the reduction of fuelwood use when cooking dense food items.

### *Analysis of Fuelwood Consumption*

Because corn porridge is a staple food in rural Tanzania, the findings on fuelwood consumption while cooking corn porridge are significant. The first comparison in Exhibit 4 displayed that the three-stones consumed less fuelwood on multiple occasions. It was surprising and unexpected for the author to find that a larger amount of fuelwood was consumed by the stove when cooking corn porridge. Corn porridge starts out as corn flour; the lightweight aspects of corn flour allow it to cook rapidly over a direct fire with the three-stone method. When using the stove to cook corn porridge, the design of the stove deters the heat from reaching the pot as rapidly as it does with the three-stones. For this reason, it is more effective to cook corn porridge with the three-stones. The greatest efficiency of the stove occurs after it has been in use for a short duration and reaches its thermal mass, maximizing heat transfer to the pot. As observed in the charts, the denser food items such as pumpkin and beans mixed with corn, which take longer to cook, are best cooked with the stove where the heat retention maximizes stove efficiency consuming less fuelwood. Qualitative results imply that improved cookstoves require less fuelwood per week then the three-stone method. This finding suggests that increased use of cookstoves can potentially reduce overall fuelwood consumption and deforestation in Measkron.

### *Fuelwood Collection*

Because of the reduction in fuelwood consumption, there is an inevitable reduction in fuelwood collection. Survey results on fuelwood collection from questions 1 and 2 revealed that 24 users reduced their frequency of fuelwood collection after they began using the improved cookstove. Two participants bought their fuelwood and were able to decrease the money spent on this weekly expense.

Participants claimed that the daily average household fuelwood use is 3-5 kg. The following nine villages border the forest reserve of Mount Hanang: Barjomot, Gawbadaw, Gendabi, Getaghul, Gitting, Jarodom, Katesh, Measkron and Nangwa. Below, Table 3 shows fuelwood consumption for each cooking method including the potential reduction in fuelwood consumption as a result of stove adoption. Daily averages for each cooking method were multiplied to the total daily fuelwood use for these combined households which is 15,187 kg. In order to take into consideration the use of other biomass fuel, corncobs and corn stalks in place of fuelwood, conservative calculations were made.

| | **Daily** | **Monthly fuelwood consumption** | **Annual fuelwood consumption** |
|---|---|---|---|
| **Fuelwood consumption (Three-stones)** | **4 kg Avg.** | **1,822,440 kg.** | **21,869,280 kg.** |
| **Fuelwood consumption (Improved Cookstove)** | **2.5 kg. avg.** | **1,139,025 kg.** | **13,668,300 kg.** |
| **Fuelwood Consumption avoided w/Improved Cookstoves use** | | **683,415 kg.** | **8,200,980kg.** |

**Table 3 Potential Fuelwood Consumption** ***Avg. household size is 5.6 (Tanzanian Census 2002)**

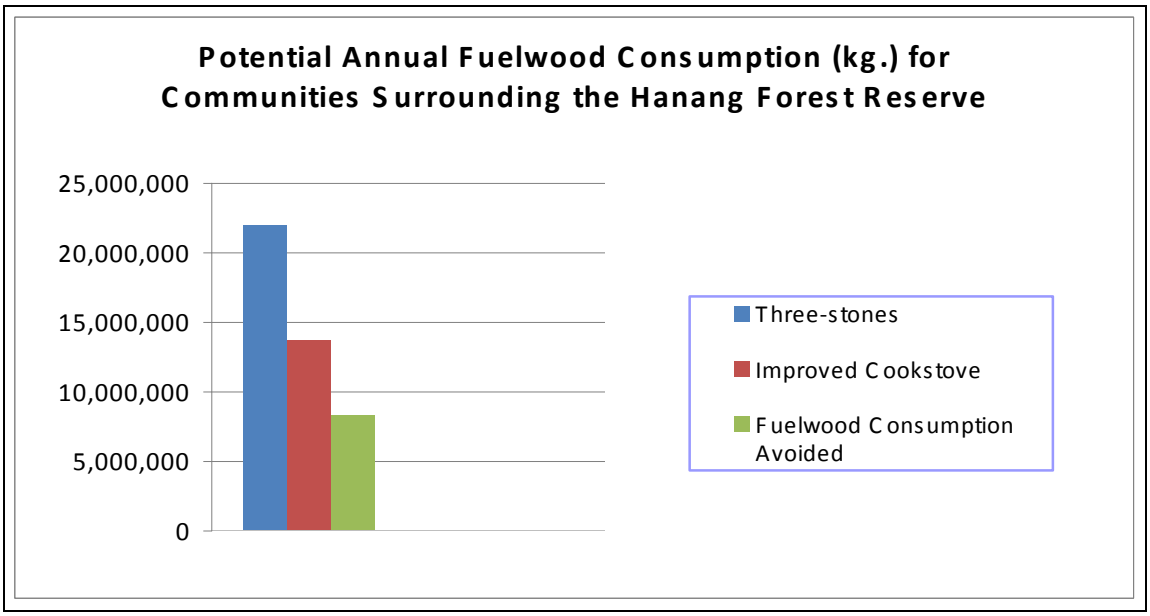


**Table 4 displays the potential annual fuelwood consumption figures from Table 3 in a chart format**

## Chapter 11: Survey Results

During follow up visits time and time again, participants enthusiastically reported high levels of satisfaction with the features of the improved cookstoves. Overall, participants expressed enthusiasm and satisfaction with the immediate benefits received by stove use. The main advantages of the stoves compiled from follow-up survey results include the following:

- All participants experienced a 50% reduction in overall fuelwood consumption

  (equates to less fuelwood collection trips/ fuelwood purchased)

- Reduction in time spent on cooking meals

- Reduction in smoke levels

As explained to the cohort, part of the motivation for this case study was to lessen deforestation in Measkron Village by reducing fuelwood consumption. In order to understand the perceived role improved cookstoves play in this rural Tanzanian village, discussions on

deforestation of Measkron were tracked. Out of 26 participants, four commented and perceived to understand the link between fuelwood dependence, and how improved cookstoves can decrease local deforestation. One woman had served as the village Mayor for four years, worked on community tree farm projects and had a college education, which may have contributed to her understanding of deforestation. The second woman had Peace Corps volunteers as her neighbors for four years whom she worked closely with; for this reason, she may have been exposed to a broader information base then most. The last woman lived within a quarter-mile radius all her life where she had gathered fuelwood from the same trees which had a significant contribution to her local knowledge and experiences. She had also mentioned watching the news on television (at a local bar), which contributed to her knowledge base of happenings beyond Measkron and the continent of Africa. Lastly, one woman had commented about fuelwood shortages/deforestation being a problem while talking with the author in public and then weeks later while at her home cooking with her improved cookstove, she smiled and claimed the opposite: fuelwood shortages were not a problem.

What these discussions tell us is that some of the women did seem to have an understanding about the link between stove use and deforestation. However, we cannot make the assumption that the other participants who did not comment about stove use and deforestation did not comprehend the association.

***Health, household and livelihood benefits***

Other survey results suggest women are able to multi-task well. They can cook two items using different methods simultaneously. For instance, they can fill the improved cookstove with wood while and leave items to cook unattended because of the fire is protected within the cement

walls. While one might think there would be worry about children falling into open fire, this doesn't happen because the fire is enclosed in cement walls. Since the fire is enclosed and requires less fuelwood to cook with, less indoor smoke pollution creates a healthier home setting.

Women are aware that since the stove remains hot for a short while after the cooking is finished, it is available for other uses. Water can be heated for tea, bathing, and washing clothes or dishes. Women also use embers from the previous evening's fire that are hidden under the ash to begin the next day's fire.

Observations made by the author supported the recorded data, as three women had been observed cooking corn porridge on the three-stones after they had made an improved cookstove. The author found 24 users continued to use both methods for cooking which allowed them to cook the staple food corn porridge concurrently with a second dish or beverage. Two women got rid of their three-stones entirely.

***Barriers to Acceptance***

Because the women who lived in the central part of Measkron were familiar with the improved cookstove, awareness about the stoves was pre-established, but cost was a significant barrier for many. Word-of-mouth was the primary mode of knowledge transmission about the stoves. Women told each other about the stoves and/or directly experienced the benefits, which greatly contributed to the acceptance and use of the stoves. Women living outside the central radius of Measkron, in the hillsides, were less accepting of this new technology and viewed it as an intrusion to the customary traditional method of cooking. However, there was the occasional woman who lived in the outskirts of town that heard about the stoves and showed genuine interest in owning one. Some women were able to save money or acquired money from their husbands or

neighbors to buy a stove, but most women who didn't have a stove and wanted one, claimed that they couldn't afford it.

***Evaluation of Survey Instruments***

The researcher made every attempt to visit participants on a consistent basis, but due to the demands of harvest season participants were often working on their farms. Beginning the field work at the end of harvest season would have been more practical. Although multiple follow up visits were made with all participants, a more effective evaluation process would have included before and after interviews where in each case, the researcher would sit with the participant while they prepared a meal cooking with the three stones, and then later, with the stove. This would have allowed the researcher to make inquires while participants were actually cooking, creating a relevant setting for in depth questioning and observation. Part of the challenge with this approach is that most women did not have a set cooking time.

Due to the distance from Measkron and data collection challenges women who lived in the nearby town Katesh purchased stoves but were not part of the case study. If more time were available, it would have been interesting to include follow up surveys from these women and compare the differences in findings.

The first day the researcher returned to Measkron, she learned that she would need to be prepared for data collection at any time. Data collection would not take place at designated times as the researcher first thought it would; women, men and children revealed information to her anytime they felt the desire to do so. Initially, the researcher thought she could recall and document qualitative data later in the day. After two days, she realized this documentation method was ineffective her head was constantly filled with new events and experiences.

In order to capture all the qualitative data, the researcher purchased a medium sized 5x7 notebook at a local shop in Measkron. While the researcher carried it around, the notebook drew a great deal of attention and people constantly asked to view it, sometimes commenting about notes taken. In several circumstances, participants asked the research to purchase notebooks for their children to use in school. During the second week, the researcher switched to a smaller more user friendly 3x4 notebook, which was placed in her pocket and concealed, drawing less attention to herself.

The survey questions worked well for a guide, but were not successful information gathering tools unless the researcher was present. Seventeen months away from Measkron caused the researcher to fail to remember how rarely community members used paper for knowledge transmission, communication and recording information. Most households do not own paper pads and writing utensils were scarce. In one instant, the survey questions were handed to a participant and immediately handed back to the researcher. The participant asked the researcher what she wanted to know and said she could answer the questions while braiding her neighbor's hair at the same time. The researcher found it more effective to interpose open ended interview questions into general conversations. This technique increased dialogue and allowed participants to freely express their insight and justify their reasoning. In contrast, direct yes or no survey questions were narrow and restricted responses.

## Chapter 12: Concluding Thoughts

The case study results reveal that there is an overall reduction in fuelwood consumption for women who adopted improved cookstoves. Singular test comparisons of both cooking methods

do not consecutively show a reduction in fuelwood use; differences occur with different food types as show in Exhibit 6 (pg. 25). Because of the low density of corn flour, cooking corn porridge with the three stone method actually uses less fuelwood because the heat from the direct flame is exposed to a greater surface area of the pot than with the cookstove. Due to the lower air to fuel ratio with the cookstoves, the increase in velocity maximizes heat transfer is maximized causing more efficient cooking (Scott, 2009). Furthermore, the light density flour cooks faster than other foods.

An additional factor that may have caused different levels of fuelwood use with the two cooking methods is fuel wood type. As mentioned, Grevillia was the most common wood type used in Measkron but it is possible that women used different types of wood on occasion and did not record this information on their data sheets.

The data previously presented in Table 3 (pg. 27) shows the projected reduction in total monthly/annual fuelwood consumption for villages surrounding Mount Hanang. However, it cannot be determined whether this equates to a comparable reduction in fuelwood consumption without conducting longitudinal studies and measuring the level of stove use as well as the rebound effect. Additionally, a reduction in deforestation that happens specifically from fuelwood collection may occur but deforestation is caused by several activities, as previously mentioned, that also require examination.

Overall, participants were highly satisfied with the performance of the improved cookstove. The stove offers, for some, an affordable alternative form of cooking. This case study demonstrates that stoves are an effective means to reduce fuelwood consumption in particular cooking scenarios, but not all. Due to the lack of significant fuelwood savings while cooking corn porridge, a staple food for rural Tanzanians, it is sensible to promote stoves as a supplemental

cooking method in Tanzania, not a replacement to the three-stone method. Promoting the stove as a supplemental cooking method provides women with a valuable alternative cooking option in a community where no other low cost options exist. Not forcing women to discontinue traditional cooking practices demonstrates cultural respect to Tanzanians who have been scared by enforced colonial practices that destroyed subsistence livelihoods. Furthermore, households are able to retain the beneficial aspects of cooking with the traditional method: ambient heat, light, food, versatility and time-honored tradition.

All 26 participants from the sub-group requested to have a stove built establishing that an interest in improved cookstoves was prevalent throughout Measkron and not insisted upon by the author. This case study in Measkron revealed that acceptance and dissemination of improved cookstoves is possible in situations where first, the stoves are well received by a key informant who then, through word of mouth, paves the way for broader dissemination. Additionally, determining a cost range for stoves needs to be decided on a case-by-case basis with consideration placed on demographics and most importantly, insightful information provided by community members. Outsiders do not have the same scrutiny and longitudinal perspective as those with local knowledge who can better settle on an affordable and practical price.

Considering the broad satisfaction and claimed benefits experienced by stoves users, there is pertinent justification to continue stove programs in communities dependent on forest resources for household energy. Furthermore, stoves offer one simple cooking alternative to women who have very few options for labor-intensive household chores.

## Chapter 13: Limitations

Collecting quality data in Measkron was limited by high levels of uncertainty associated with government leaders in flux, subsistence lifestyles, living conditions and different ways of knowing between the author and the participants.

### *Government Support*

Three months prior to her arrival in Hanang District, the author made arrangements with the Regional Commissioner (RC) of Manyara to collaborate on stove building projects; the author had collaborated with the RC on previous occasions. When the author arrived to Hanang District in June 2007, there was a new Regional Commissioner who was not aware of the improved cookstove project. Due to this change in leadership, the author no longer had project support from the regional government, nor did she have support of local government officers since Measkron Village did not have a mayor in office at the time. Had the author received support from regional and local government, she may have had the opportunity to increase her sample size.

### *Data Collection*

During 27 months of participant observation, the author never observed women using watches to assist them while cooking. The greatest challenge in the case study involved having women, who do not write on a daily basis, record numeric information on their cooking practices. The initial sub-group selected to record data consisted of ten women. Seven out of ten participants from the sub-group recorded quality data: one participant had limited reading and writing abilities not obvious during the consultation, another participant ran out of fuelwood,

used corncobs as a substitute and then gave her stove away to her mother. The third participant claimed that her data chart was stolen and likely eaten by a rat.

Other limiting factors were caused by the sons of two participants who stole and broke watches that were used to track cooking data. Lastly while conducting follow-up surveys, one participant was sick on three occasions, which limited her ability to record data and provide feedback.

## Chapter 14: Suggested Future Studies

Additional studies are suggested to further examine the role and function of improved cookstoves: regional studies testing effectiveness of improved cookstoves on different food types; longitudinal studies of improved cookstove use on the environment and human health; promotion of improved cookstove projects in conjunction with micro-lending to reduce poverty; improved cookstove use and the rebound effect; improved cookstove use as a measure to reduce black carbon emissions and ultimately mitigate climate change; and improved cookstoves as a form of carbon trading.

Literature Cited


Beck, K. (2008). Peace Corps Volunteer, Tanzania 2003-05. In M. Holmes (Ed.) (ambient heat, household comfort ed.).

Cecelski, E. (2001, May 1, 2001). *Gender and Access to Energy Services* Paper presented at the 14th Session of the United Nations Commission on Sustainable Development, Germany.

Clark, M. E. (1989). *Ariadne's Thread: The Search for New Modes of Thinking*. New York: St. Martin's Press.

Creswell, J. & Plano, V. (2008). Designing and Conducting Mixed Methods Research and The Mixed Methods Reader. Los Angeles: Sage Publications.

Darema, M. (2007). Personal Assistant to the Member of Parliament for Hanang Constituency. In M. Holmes (Ed.). Katesh Town

Dawson, E. (2007). Peace Corps Environmental Volunteer Placement Coordinator. In M. Holmes (Ed.) (Text message ed.). Measkron.

Development, A. f. E. (2007). *Fuel Efficient Stove Programs In IDP Settings- Summary Evaluation Report, Uganda* (No. DOT-1-00-04-0002-00). Washington, DC: USAID.

Erckle, S. (2009). Peace Corps Volunteer Tanzania 2007-09. In M. Holmes (Ed.). Olympia, WA.

Ergeneman, A. (2003). *Dissemination of Improved Cookstoves in Rural Areas of the Developing World: Recommendations for the Eritrea Dissemination of Improved Stoves Program*: Eritrea Energy Research and Training Center (ERTC).

Ezzati, M., & Kammen, D. M. (2002). The Health Impacts of Exposure to Indoor Air Pollution from Solid Fuels in Developing Countries: Knowledge, Gaps, and Data Needs. *Environmental Health Perspectives, 110*(11), 11.

Foundation, U. N. (2008). *Blueprint for Action*: The West African Economic Monetary Union, Biomass Energy Regional Program The Hub for Rural Development in West and Central Africa.

Gill, J. (1985). *Stoves and Deforestation in Developing Countries*. Paper presented at the UK-ISES Conference, "Energy for Development- what are the solutions?"

Government of Tanzania. (2008). The Official Tanzania National Website. Retrieved 3/4/2008, 2008, from http://www.tanzania.go.tz/energyf.html

Haider, M. N. (2002). *Success without Subsidy A Case Study of the Fuel-Efficient Smokeless Stoves Project*. Changa Manga, Pakistan: United Nations Development Programme.

Hamilton, A. C. (1984). *Deforestation in Uganda*. Nairobi: Oxford University Press and the East African Wildlife Society.

Harding, D. M. S. M. H. (2003). *Health and Environmental Effects of Cooking Stove Use in Developing Countries*.

Hiner, C. (2008). Peace Corps Volunteer, Tanzania 2004. In M. Holmes (Ed.) (Furthermore, we development workers remain - despite our best efforts at the contrary - outsiders imposing our own version of "development" or "progress" on others. ed.).

Holmes, M. S. (2007). Tanzania Fuel-Efficient Stove Project. Unpublished Field Work Case Study Evergreen State College.

IndexMundi. (2008, December 18, 2008). Population Growth Rate of Tanzania. Retrieved August 23,2008, 2008, from http://indexmundi.com/tanzania/population_growth_rate.html

Jagadish, K. S. (2004). The development and dissemination of efficient domestic cook stoves and other devices in Karnataka. *Current Science, 87*(7), 5.

JAICA, Japan International Cooperation Agency (2006). *The Study on the Groundwater Resources Development and Management in the Internal Drainage Basin in the United Republic of Tanzania*. Hanang: Internal Drainage Basin Water Office Ministry of Water.

Johnson, A. (2007). Resident of Measkron In M. Holmes (Ed.) (chore of fuelwood collection takes 1-2 hours longer ed.).

Johnson, B. & Onwuegbuzie, A. Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, Vol. 33, No. 7, 14-26 (2004)

Kaale, B. (2005). *SADC Programme for Biomass Energy Conservation (ProBEC)*. Dar es Salaam: Ministry of Energy and Minerals.

Kammen, D. (1995). Cookstoves for the Developing World. *Scientific American*.

Lynch, M. (2002). Reducing Environmental Damage Caused by Cooking Fuels. *Refugee, 21*(1), 9.

Manuel, J. (2003). The quest for fire: hazards of a daily struggle. *Environmental Health Perspectives, 111*(1), A28-33.

McConnell, B. (2008). Peace Corps Volunteer, Tanzania 2003-05; The Gambia 2006 (households that depend on smoke for beneficial uses ed.).

Mission, Masons on a Mission (2006). Masons on a Mission in San Pablo la laguna Guatemala. Retrieved 4/5/2009, 2009, from http://www.midcoast.com/masonsonamission/.

Mongabay. (2005). Statistics Tanzania. Retrieved October 17, 2009, 2007, from http://rainforests.mongabay.com/deforestation/2000/Tanzania.htm

Mwati, K. (2007). Tanzanian Masonist. In M. Holmes (Ed.). Katesh.

Persha, L. (2002). *Chome Ward Fuel Efficient Stove Survey Follow-Up*. Chome.

Petersen, E. (2008). *Forest Resources and Livelihoods: Evaluating Local Forest Management in Barjomot Village, Tanzania.* University of Washington, Seattle.

Policy, The Center for Ecology and Law. (2007, July 12, 2007 ). The Management and Ecology of Tanzanian Forest Reserves. Retrieved October 17, 2007, from www.york.ac.uk/res/celp/webpages/projects/ecology/forest%20reserves/arusha.htm#HANANG

Program, United Nations Development Programme (1999). *Disseminating Efficient Cookstoves, Bhutan*. Tsirang: The Small Grants Programme.

Rehfuess, E., Mehta, S., & Pruss-Ustun, A. (2006). Assessing household solid fuel use: multiple implications for the Millennium Development Goals. *Environmental Health Perspectives, 114*(3), 373-378.

Rudestam, K.E. & Newton, R. R. (2007). Surviving Your Dissertation A Comprehensive Guide to Content and Process 3rd Edition. Thousand Oaks: Sage Publishing.

Sale, Joan M; Lohfeld, Lynne H. and Kevin Brazil (2002). Revisiting the Quantitative-Qualitative Debate: Implications for Mixed-Methods Research. *Quality and Quantity, 36*, 43-53.

Schlesinger, L. (2008). Peace Corps Volunteer, Tanzania 2003-05. In M. Holmes (Ed.) (Tanzania resulted in stoves which sat idle or were used for other purposes such as stools ed.).

TECA. (2006). Labour Saving Technologies. Retrieved 12/6/2006, 2006, from www.fao.org/sd/teca/tools/1st/LSTP26_en.html

Trust, Sunseed Tanzanian. ( 2009, Monday, February 23, 2009). Stoves. Retrieved March 16, 2009, 2009, from http://www.sunseedtanzania.org/stoves.php

TWP, Trees Water People (2006). Fuel-efficient Stove Programs. Retrieved 9/22/2006, 2006, from www.treeswaterpeople.org

Wallin, R. (2008). Peace Corps Volunteer, 2003-05. In M. Holmes (Ed.) (households that depend on smoke for beneficial uses ed.).

Zein-Elabdin, E. (1997). Improved stoves in Sub-Saharan Africa: the case of the Sudan. *Energy Economics, 19*, 465-475.